 Issued July 20, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR THE

YEAR ENDED JUNE 30, 1906.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

JOINT RESOLUTION providing for printing annually the Report of the Director of the Office of Experiment Stations, Department of Agriculture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed eight thousand copies of the Report of the Director of the Office of Experiment Stations, prepared under the supervision of the Secretary of Agriculture, on the work and expenditures of that Office and of the agricultural experiment stations established in the several States and Territories under the act of Congress of March second, eighteen hundred and eighty-seven, for nineteen hundred and three, of which one thousand copies shall be for the use of the Senate, two thousand copies for the use of the House of Representatives, and five thousand copies for the use of the Department of Agriculture; and that annually hereafter a similar report shall be prepared and printed, the edition to be the same as for the report herein provided.

Approved, April 27, 1904.

THE OFFICE OF EXPERIMENT STATIONS.

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Drainage engineers.—J. O. Wright, J. T. Stewart, C. F. Brown, Lawrence Brett, L. L. Hidinger, H. A. Kipp, J. W. Martin, D. G. Miller, W. G. Miller, Omar Fairley, F. G. Eason, J. R. Dickson, V. M. Cone, E. W. Chadwick.

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W. B. Gregory, Studies of pumping and rice irrigation, Tulane University, New Orleans.

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B. C. Buffum, M. S., Studies of methods of conserving moisture, University of Wyoming.

G. H. True, B. S., Studies of duty of water, University of Nevada.

O. L. Waller, Ph. M., Studies of duty of water, State College of Washington.

A. R. Whitson, B. S., Studies of farm drainage in Wisconsin, University of Wisconsin.

J. B. Davidson, B. S., Studies of farm drainage in Iowa, Iowa State College.

C. E. Lucke, Investigations of the power value of alcohol, Columbia University, New York.

B. A. Etcheverry, B. S., Studies of methods of preventing seepage losses from ditches, University of California.

LETTER OF TRANSMITTAL.

OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 30, 1907.

SIR: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, the publication of which is authorized by joint resolution of the Fifty-eighth Congress, second session. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1906, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

There is also a report for the same year on the receipts and expenditures and work of the stations under the act of Congress of March 16, 1906, in accordance with section 5 of that act.

Very respectfully,

A. C. TRUE, *Director.*

HON. JAMES WILSON,
Secretary of Agriculture.

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ANNUAL REPORT OF THE OFFICE OF EXPERIMENT STATIONS, JUNE 30, 1906.

WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of Federal funds by the agricultural experiment stations throughout the United States; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico; special investigations on the nutrition of man and on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories, and the promotion of the interests of the agricultural colleges and schools and farmers' institutes throughout the United States.

RELATIONS WITH THE AGRICULTURAL EXPERIMENT STATIONS.

The duties and responsibilities of the Office of Experiment Stations have been materially broadened and increased as a result of the passage of the act of Congress of March 16, 1906 (Adams Act), "providing for an increased annual appropriation for agricultural experiment stations and regulating the expenditure thereof." Under the terms of this act the Secretary of Agriculture must annually "ascertain and certify to the Secretary of the Treasury as to each State and Territory, whether it is complying with the provisions of this act and is entitled to receive its share of the annual appropriation for agricultural experiment stations under this act, and the amount which therefore each is entitled, respectively, to receive," and "make an annual report to Congress on the receipts and expenditures and work of the agricultural experiment stations in all of the States and Territories, and also whether the appropriation of any State or

Territory has been withheld, and if so, the reason therefor." He is also charged in general terms "with the proper administration of this law." On March 20, 1906, the Secretary of Agriculture sent a letter to the directors of the agricultural experiment stations in the several States and Territories in which he stated that "the Director of the Office of Experiment Stations is hereby designated my representative in all matters relating to the business of this Department in connection with the administration of this law, and the Office of Experiment Stations will aid in promoting effective work under this act in the same general way as it has heretofore in relation to the Hatch Act."

Under the authority thus conferred by the Secretary the Office immediately took measures to determine what stations were entitled to receive the benefits of the Adams Act, to make the necessary arrangements with the Treasury Department preliminary to the payment of the installments of the Adams fund as they became due, to prepare and issue the schedules for reports of the expenditures of this fund for the past fiscal year, and to reach an understanding with the stations regarding the lines of work and the expenditures allowable under this act.

It is already evident that the business of this Office in relation to the work and expenditures of the stations under the Adams Act will be considerable in amount and will have much importance as a factor in determining the kind of progress to be made by these institutions. The organization of lines of work which may fairly be called "original research" in agricultural problems has occasioned much discussion as regards the nature and scope of such work as related to conditions existing in the several States and Territories, the men to be selected as investigators, the means and appliances needed to make the work undertaken successful, etc. The policy of the Office, as heretofore, is to endeavor to formulate and hold to such general principles in the administration of the Adams Act as seem most likely to secure the efficient use of the Adams fund for research work of a high and substantial character and at the same time to safeguard the autonomy of the stations and raise their work and its results in the estimation of their farmer constituents. This involves much additional correspondence and personal conference in order that the best results may be obtained. Through the cultivation of more thorough acquaintance with the managers and workers of our stations, and through participation in the councils of the Association of American Agricultural Colleges and Experiment Stations, this Office hopes to be able to act as a gatherer and disseminator of sound views regarding the aims and methods of research work in agriculture in such a way that its utterances will have behind them the substantial consensus of the men best qualified to judge of the

needs and requirements of American agriculture as related to the work of agricultural experiment stations, whose work shall rest on a firm basis of scientific principles and their application to practical ends.

This Office has continued to make careful inquiry regarding the use made by the stations of the funds granted to them under the Hatch Act, and to aid them in securing liberal State and local appropriations for cooperative and other experiments in different localities, for publishing the results of their work, and for such practical tests and demonstrations as will best show how the results of agricultural research may be applied in a broad way for the improvement of agricultural practice. The States and local communities have of late shown a most encouraging disposition to give the stations such financial support as they require to make the results of their work broadly effective, and it is believed that this will continue to be done wherever the station managers show themselves alert to the best interests of agriculture and worthy of the confidence and support of practical men.

The steady growth of institutions for agricultural experimentation throughout the world is reflected in the enlarged business of this Office in its relations with the foreign stations. There are now more than 1,000 institutions in over fifty countries which are engaged in investigations bearing directly on agricultural problems. Friendly and helpful intercourse between these institutions wherever located is growing in importance and usefulness. This Office is coming into closer touch with the foreign stations, is getting more regular and complete accounts of their work, and is publishing an increasing amount of information from these sources which is useful to our investigators, teachers, and farmers.

The broadened scope and extent of the work of institutions for agricultural investigation at home and abroad is shown in the constantly increasing mass and variety of the literature reviewed in the Experiment Station Record. The seventeenth volume of the Record was completed during the past year and, as heretofore, included abstracts of the publications of the agricultural experiment stations in the United States, the United States Department of Agriculture, the researches of experiment stations and similar institutions in all parts of the world, and a large number of articles having a direct bearing upon agricultural science which are published in the scientific journals at home and abroad. It has thoroughly maintained its well-established character of a world review of agricultural experimentation, and it remains the only journal of the kind published under governmental or private auspices. The careful discrimination necessary to the collation of such an abstract journal has been exer-

cised to keep it within the scope and character determined upon and to restrict the review to articles which are worthy of the attention of agricultural experts and scientists.

The appreciation in which the Experiment Station Record is held is more manifest each year. It becomes a repository of information which can not be found without very extended and time-consuming research of the literature, and as time goes on the carefully indexed volumes become of increasing value and a practical necessity to men who are looking up subjects of investigation. The inauguration of more advanced investigation under the Adams Act gives the Record an increased value and importance. It enables the workers to follow the progress of experimentation and research in various lines, and makes them more resourceful and useful men for such work.

The Record is being used more largely than ever before for the discussion of the principles on which scientific and practical investigations in agriculture should proceed and for pointing out lines of research which need further development and suggesting methods for the strengthening of the organization and work of the stations.

Efforts are also being made to perfect and extend the popular review of the practical results reached by our stations which is embodied in the series of Farmers' Bulletins entitled "Experiment Station Work," prepared under the general editorial management of Mr. W. H. Beal. Being published in large editions and widely distributed, these bulletins disseminate the practically useful results of experiment station work more thoroughly than can be done by the individual stations themselves through their comparatively limited editions of bulletins and reports, which, moreover, are in many cases restricted to distribution in the particular State in which the station is located. The fact that these bulletins attempt to present careful and conservative summaries of the best available knowledge on a great variety of agricultural topics has led to their being used more and more by the experiment stations and by this Office in answering the numerous inquiries on various subjects which are received.

The work of this Office, and especially its relation with the agricultural colleges and experiment stations, was illustrated by an exhibit at the Lewis and Clark Exposition, at Portland, Oreg., during the summer and fall of 1905, and arrangements have been made for a similar exhibit at the Jamestown Tercentennial Exposition to be held in 1907.

The Assistant Director, Dr. E. W. Allen, has continued to have special supervision of the business of the Office connected with the work and expenditures of the stations.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

ALASKA STATIONS.

The policy announced in previous reports of confining investigations at each of the Alaska stations to some definite problems has been continued with good results. Attempts at grain growing have been abandoned at the Sitka Station, but the cultivation of cereals is made the main feature of the work at the Copper Center and Rampart stations, where there are large areas of land capable of cultivation.

At the headquarters station at Sitka the principal offices are maintained, and from here the work of the other stations is directed. The experimental work at Sitka consists very largely of horticultural investigations, which include not only all of the garden crops, but bush fruits as well, and some experiments with orchard fruits, particularly apples, cherries, and plums. The station has been propagating, cultivating, and distributing a considerable amount of nursery stock with a view to ascertaining what if any varieties are suited to Alaskan conditions. During the years 1905 and 1906 there were distributed to more than 300 addresses 2,716 apple trees, 2,204 currant and similar bushes, and 1,874 raspberry plants. About 30 of the hardiest varieties of apples have been secured from various sources, and their growth and hardiness are being observed. Advantage is being taken of the occurrence of a native crab apple (*Pyrus rivularis*), and it is being used quite successfully as a stock on which to graft a number of varieties, crown grafting seeming to give the best results.

In addition to varietal tests of strawberries, raspberries, currants, etc., attempts are being made to domesticate the wild species of these plants. Successful efforts have been made in hybridizing the wild strawberry with some of the cultivated sorts, the cultivated raspberry and the salmon berry, wild and cultivated raspberries, and others, the object of these breeding experiments being to secure the hardiness of the native species and the improved quality of the cultivated varieties.

An extended series of experiments is in progress at the Sitka Station to determine the best varieties of cabbages, cauliflower, and potatoes for Alaska, and also to determine the relative merits of Alaskan grown and imported seed potatoes of different varieties. These experiments will be continued until it will be possible to definitely recommend varieties for Alaskan cultivation.

At the Copper Center Station attention is being paid to the growing of grains and forage, about 40 acres being under cultivation, 10 acres of which are in permanent grass plats. The growth of the crops was heavier this year than usual, doubtless due to an unusual

amount of rain during the growing season. While the growth was heavier, the wet season prolonged the growing period and most of the grain was destroyed by frost the latter part of August. Nearly all the frosted grain was cut for hay, the yield ranging from one-half to 2 tons of hay per acre. The surplus hay was sold at an average of $200 per ton. On many of the plats of oats, barley, rye, etc., a few heads were matured, and these have been saved for seeding purposes in the hope that earlier maturing varieties may be developed. Among the forage plants alsike clover, timothy, and smooth brome grass seem promising. Tall fescue and one of the western wheat grasses (*Andropyron tenerum*) made excellent growth throughout the season, and it is believed that they will prove adapted to their surroundings. The effect of cultivation of the soil and the use of fertilizers was well shown in the improved stand and heavier yields where fertilizers were used. The gardens, not only at the station but also throughout the Copper River Valley generally, were unusually good the past season. The experience with potatoes at the Copper Center Station was truly remarkable. Several small plats were well fertilized with stable manure and planted to several varieties of potatoes. The crop was dug September 8 and the yield was at the rate of more than 400 bushels per acre, 98 per cent of which were smooth, marketable potatoes.

The experiments at Copper Center Station during the past season have fully demonstrated the practicability of producing grain hay and raising potatoes at a considerable profit. At present practically all winter feed must be hauled from tide water, 110 miles away, and it is shown that seeding oats at the rate of 2 or 3 bushels per acre will produce a good crop of hay.

At Rampart Station grain, both fall and spring sown, matured, although the station is fully 150 miles farther north than Copper Center. Every year since the station was established in the Yukon Valley grain has matured. The past season three varieties of winter rye and one of wheat survived the winter and matured their crop. Of the spring-sown grains three varieties of barley, two of oats, and one of buckwheat were matured. As at the other stations, plant breeding work is being carried on, and the earliest maturing heads of every variety of cereal are selected for further planting. A number of plats have been seeded to grasses as a test of their adaptability. Several varieties have grown well during the past season and made a good stand. As the snowfall is usually sufficient for winter protection, it is probable that some may be established and prove adapted to extensive sowing in the Yukon Valley.

At the Kenai Station the work is now devoted wholly to animal husbandry and to the growing of feed for live stock, testing grasses and other forage plants, and dairying. There are 26 acres under

cultivation at this station, the greater part of which was sown to oats and cut for hay. Under the special appropriation for the introduction of live stock 11 head of Galloway cattle were purchased, 7 of them being sent to the Kenai Station and the others placed in charge of Mr. C. P. Coe, on Wood Island. The addition to the Kenai herd of cattle brought the total up to 17 head, all of which are reported as being in good condition. The introduction of the Galloways was attended with success, and the animals proved docile, quickly recovered from the effects of their long voyage, and when last reported were in excellent condition on the forage found in the native pastures. There seems to be no doubt of their adaptability to Alaskan conditions. A small dairy outfit has been supplied to this station, and butter of excellent quality was made, although the cows producing it were those purchased from settlers and are not to be considered as first-class dairy animals. The experiments with cattle thus far have shown that dairying and cattle raising are possible and practicable in this part of Alaska, so far as pasturage is concerned. There are here and there extensive tracts of pasture land, although the areas that could be mowed are limited to patches of from 5 to 40 acres. Experiments at the station show that besides the possibility of growing grain hay, a number of grasses are apparently well adapted to this part of Alaska. Among those most promising are the native blue top, a native bunch grass, tall fescue, timothy, meadow foxtail, smooth brome grass, and white and alsike clover. Blue grass also does well in some localities, and experiments are now being carried on with a number of native species of grasses that are thought promising. With the construction of the railroad from Seward toward the Tanana country, the west side of the Kenai Peninsula will become even less accessible than it is now, and the advisability of moving the animals to some other location will have to be given consideration.

A station site was located last year in the Tanana River Valley between Chena and Fairbanks, and it is expected that some work will be inaugurated there the coming season. The Tanana Valley contains large areas of land so situated as to be adapted to cultivation, and from reports of limited experiments it is believed that this region is capable of considerable agricultural development.

The Alaska stations, as in the past, have cooperated with many residents in various parts of the country, and flattering reports of success have been received. Through the courtesy of the Bureau of Plant Industry garden seeds were supplied to about 2,000 addresses. This courtesy is highly appreciated, as in many cases this is the only source from which seeds may be secured, and the distribution should be continued as heretofore. The assistance of the Bureau in securing varieties of seeds and plants from high latitudes in Europe and elsewhere is gratefully acknowledged.

HAWAII STATION.

The Hawaii Station has continued the policy of devoting its energies to the diversification of agriculture in the Hawaiian Islands, and there appears to be a decided change in the sentiment on the part of many persons regarding the possibility of the development of other agricultural industries than those connected with the production of sugar. During the six years since the organization of the station a number of industries have been successfully established or extended in Hawaii, among them pineapple growing, sisal production, tobacco raising, etc. During the past year considerable work has been done in bringing more of the station land under cultivation in anticipation of the new water system provided for by Congress. In this way about 10 acres were prepared for cultivation. Considerable additions were made to the library by purchase, exchange, etc., so that the station now possesses the best collection of reference books in Hawaii treating of economic agriculture in its various branches.

Among the field investigations at the station mention may be made of an experiment with potatoes in which it was shown to be possible to produce new potatoes for the local market at a very remunerative price. The plants were severely attacked by potato rot and the yield considerably reduced, so that probably the liability to the occurrence of this disease will have to be considered.

During the past year seven varieties of cotton were grown and samples of the fiber submitted to experts for examination. The upland varieties on the whole were not very promising, but the sea-island type was reported as of good length, excellent strength, and unusual fineness. One sample of upland was very variable in its lint, some portions being quite ordinary, while others had a length and fineness of fiber equaling sea island. This sample seems to afford an excellent opportunity for improvement by selection in case the growing of cotton should be undertaken on a commercial scale.

The orchard plantings of tropical fruits have been considerably extended and now include such fruits as the mango, avocado, bread fruit, cherimoya, litchi, longan, sapodilla, wi, custard apple, and others. These are being propagated as rapidly as possible. A citrus orchard has been established, which, in addition to providing for the testing of varieties, will also supply stock for budding and grafting. The Bluefields bananas secured through the station have been distributed among about fifty growers, and favorable reports regarding them have been received. Over 500 suckers and large corms were distributed, with the understanding that the growth, production, etc., should be reported to the station from time to time. The shipping qualities of this variety are believed to be superior to those now mar-

keted from Hawaii, and their introduction will doubtless be of great advantage both to growers and shippers. The station has successfully introduced the cultivation of the roselle (*Hibiscus sabdariffa*). The fleshy calyx of this fruit and the young seed pods are used for the manufacture of excellent jam and jelly. The experiments show that this plant is well adapted to local conditions, and it is being grown on an extensive scale for distribution purposes.

Cooperative work is being carried on by the station at several places with a number of important crops. On the island of Maui a rather extensive experiment with wine grapes is in progress. One hundred and seventy-seven varieties of wine grapes were procured by the station and planted in March, 1906. The station directs the experiment, which is carried on without further expense to it. The growing of table grapes is already being carried on in a limited way by the Portuguese settlers, and with the anticipated increase of immigrants from Portugal and the Azores it is probable that grape growing and wine making can be made profitable industries.

An important experiment in rubber production is being carried on at Nahiku, on the island of Maui. This embraces tests of varieties, the use of fertilizers, methods of tapping, preparation of rubber, etc. The rapid rise in the price of rubber has resulted in extensive planting experiments throughout the Tropics, and it is believed that this industry can be made profitable in Hawaii. According to a recent report, one company on Maui has now growing 138,336 rubber trees, of which 129,800 are Ceara, 8,086 Hevea, and 450 Castilloa rubber. Experimental tappings have proved satisfactory, and it is believed that fully 100,000 trees will be yielding a profit by the year 1909. The difficulty of obtaining seed and the low vitality of some shipments are serious drawbacks to the rapid extension of rubber plantations. A small experimental planting of rubber trees and coffee has been made on the station grounds.

The tobacco investigations which were begun in 1903 have been continued with promise of great success. In 1906 the location was changed from Pohakea to a tract of government land in Paauilo that has been set aside for this purpose for a term of years. This experiment is in cooperation with the Territorial board of agriculture and forestry and a number of private individuals. In 1906 4 acres were planted to the best varieties of Sumatra and Habana tobaccos, and a curing barn 30 by 50 feet was erected. The crop of 1905 was regarded so highly that about fifty farmers and planters are this year experimenting with tobacco, and the industry seems in a fair way to become commercially established.

The station is continuing its cooperation with the Hawaiian Stock Breeders' Association in the introduction and distribution of seeds

of grasses and other forage plants. During 1906 large quantities of seeds of forage plants were procured from New Mexico, Australia, France, and elsewhere, and many of the more valuable grasses and forage plants are well established on some of the island ranches.

The entomological work during the past year has been along the lines of the control of insect depredations, investigations in silk culture and beekeeping, and studies on mosquitoes and their control. Field work in connection with the entomological investigations has taken a considerable amount of time, and experiments are being conducted to control some of the more serious insect pests of economic plants other than sugar cane. Particular attention is being given to the insects attacking pineapples, tobacco, coffee, sisal, and forest trees. In the silk-culture investigations a quantity of silkworms of a Chinese race, known as the Oro silkworms, was secured and bred for comparison with European varieties previously grown. The results obtained are very encouraging, and it is thought that silk production as a family industry can be made profitable. In connection with the station chemist, the entomologist has been carrying on studies on Hawaiian honey and the sources from which it is made. Two new races of bees have been introduced during the year, and one gives promise of being better adapted to Hawaiian conditions than the Italian bees. The entomologist has continued to act with the committee having in view the reduction of mosquitoes, and through his initiative top-feeding minnows have been successfully introduced to feed upon mosquito larvæ in taro ponds, fish ponds, rice fields, and other places where drainage and spraying are impracticable.

The chemical investigations have been divided between the usual lines of routine work and research investigations. One of the most important lines of work has been the analysis of Hawaiian-grown fodders and feeding stuffs. As the result of this investigation it is shown that in general there is a marked deficiency in the lime content of Hawaiian grasses and fodders. The effect of this deficiency on the strength and development of animals is shown not only by the station investigations, but by those of the veterinarian of the Territorial board of agriculture, and the importance of lime as a factor in feeding rations is being recognized by all. Studies were made of a number of products as sources of alcohol, particular attention being paid to the waste products from pineapple canneries. The research work has been confined very largely to soil studies to determine some of the phenomena connected with the nitrogen content of Hawaiian soils. Investigations have also been carried on regarding the high magnesium content of Hawaiian soils and its significance.

The horticulturist is giving particular attention to the subject of shipping and marketing tropical fruits. Avocados have been successfully shipped from Honolulu to New York City, Guam, and Manila. Following these experimental shipments, arrangements were made for trial shipments of pineapples, papayas, bananas, and avocados to San Francisco and other cities on the Pacific coast. These were accompanied by the horticulturist, in order that the methods of packing and handling in transit and at the destination could be studied. The tests were highly successful, and it is believed that enlarged markets for these fruits are assured whenever regular supplies can be obtained. The collections of citrus fruits are being extended, and attempts are being made to awaken an interest in the production of more and better varieties of these and other kinds of tropical and subtropical fruits.

PORTO RICO STATION.

The progress of agriculture in Porto Rico with which the experiment station has been connected has been decidedly marked during the past year. An increase in the interest regarding the work of the station can be noticed, and there is a growing desire for the published reports and frequent inquiries regarding the work itself. Sugar planting is being rapidly extended, and modern "centrals" are taking the place of numerous small mills. The greatest advance during the year has been in the consideration given to the growing and curing of tobacco. Many acres in the interior valleys have been planted to tobacco, and lands suited to this crop have increased enormously in value. Numerous large companies have been organized which not only plant extensively, but also purchase the crop of small planters, curing the tobacco themselves. This practice results in a better and more uniform product, and through the adoption of more scientific methods of curing and fermentation tobacco growing in Porto Rico should become a profitable industry. Large factories have been established at San Juan, Bayamon, and Caguas which employ many people.

The station is giving especial attention to the planting of citrus fruits and pineapples. Both of these industries have been rapidly extended the past few years, and some of the purely local problems regarding them are being given consideration. The station has important collections of citrus fruits and pineapples, and improved methods of propagation, fertilizing, and marketing fruits are being studied. About 100 varieties of citrus fruits are under observation, and in addition to introduced varieties some native seedlings have been discovered that appear of great promise. Two of these are worthy of special mention. One is a seedless orange, which was

found growing near Mayaguez, and the other, a perfect navel orange, was found near Peñuelas. Both of these are being propagated at the station.

The station collection of pineapples contains about two dozen varieties, all of which fruited this year. Further observations will be necessary on a number of these before specific recommendations can be made. A variety from Jamaica, the Ruby, proved one of the most promising of introduced sorts. It is a highly colored fruit of excellent quality, and it will doubtless prove a valuable acquisition. A variegated form of the variety Cabezona which was found near Lajas is being propagated and will be distributed under the name Variegated Lajas. It is brighter in color than the Variegated Cayenne and not only the leaves but the fruit also show the variegation, making it valuable for decorative purposes. The collection of pineapples at the station emphasizes the variation and instability of varieties of this fruit and the lack of certainty in varietal names. An exchange of plants with others of the West Indies has shown great confusion in the varietal nomenclature, and only by a prolonged study will it be possible to definitely determine some of the types. Experiments in shipping pineapples were made during the past season, and it was found possible to get them to New York markets in good condition with the present inadequate transportation facilities, where care was exercised in packing and handling. With better methods of transportation the shipment of fresh fruits to New York and neighboring markets should be very profitable. The propagation of mangoes, avocados, and other tropical fruits is being pushed as fast as possible.

The coffee investigations have been continued along the lines of improved methods of cultivation, the use of fertilizers, hybridization, etc. The station has shown the advantage of the coffee seed bed and nursery in the establishment of new plantations, and the possibility of more than doubling the yield per tree by pruning and the application of fertilizers. The station has a large number of varieties of coffee under observation to determine whether any seem adapted to Porto Rican conditions. The United States trade does not seem to take readily to the Porto Rican coffee, and if any of the better known high-priced coffees prove promising an attempt will be made to extensively introduce them into Porto Rican culture.

An experiment of considerable importance was undertaken during the past year in malting coffee. It not infrequently happens that rainy weather occurs at the time of the coffee harvest. Where no artificial means for curing coffee are at hand the crop may be lost through lack of drying. The wet coffee begins to sprout and the effect of sprouting on the quality was investigated. In December, 1905, fermented and washed coffee was thoroughly wetted and kept

in this condition for fifty-six days, the pile being stirred daily. At the expiration of this time the coffee was dried in the ordinary way and hulled. Samples of this "malted" coffee were submitted to a number of persons and their opinions requested regarding the quality of the beverage made from it. All reports were very favorable and the treatment seemed to improve the flavor to a marked degree, the bitter taste so much complained of by many seeming to be wholly removed. The results of this experiment are valuable, since they prove that coffee can be kept in a wet state and allowed to sprout for two months without injury.

With the rapid extension of sugar-cane planting a number of problems relative to the use of fertilizers have been referred to the station as the only source of scientific information on such subjects. Carrying on experiments with cane is very expensive and the station is not in a position to devote much attention to this crop except as it works in cooperation with planters. A plan of experiments with fertilizers has been devised by which any planter can test the soil requirements of his fields, and a number of the more progressive planters are testing fertilizers under the direction of the station. At the station a number of varieties of cane are being tested, among them the more promising seedling canes which were developed in the British West Indies and a collection received from the Louisiana Experiment Station. Some of these canes seem quite superior to those now extensively planted.

The station has demonstrated the possibility of the production of lowland rice in Porto Rico, and a profitable crop is now offered when for any reason land devoted to cane is to be rotated or some other change is made in the present system of agriculture.

Experiments with forage plants are being carried on, and cowpeas, Florida beggarweed, and gandule or pigeon peas have all been found to be valuable leguminous forage plants. A large white bean, known as the sword bean, is being tested, as are also a number of native leguminous plants, in order to secure a better balanced mixture of green forage than is now available in the guinea grass and malojilla.

In cooperation with the insular government the station is conducting investigations on some fiber plants, and over 100,000 sisal plants have been recently set out. Large additions to this plantation are contemplated in the hope that this industry may be placed upon a commercial basis as soon as possible. Experiments are also in progress in the introduction of the jipi-japa palm, from which the famous Panama hats are made. Attempts are also being made to reforest some of the barren hillsides with various tropical species, and the necessity for windbreaks in connection with such plantings has already been shown.

The investigations on the improvement of live stock are still in progress, and not only the experiment station but progressive planters are endeavoring to improve the quality of their farm animals. It has been shown that improved animals of various breeds can be imported and successfully acclimated providing a few precautionary measures be taken. Imported animals should be stabled and fed on grass or should be kept on small well-shaded lots until they have become used to their surroundings. Pigs, turkeys, geese, ducks, and chickens have been acclimated at the station without any loss, and it has already been shown that the hatching and rearing of poultry, if carried on during the dry season, is fairly successful.

NUTRITION INVESTIGATIONS.

Investigations on the nutrition of man, by which is meant, broadly speaking, studies of the utilization of agricultural food products of animal and vegetable origin, have been carried on by this Office during the past year in continuation of earlier work, and the same general policies have been followed as heretofore. This enterprise involves studies of the digestibility of different food materials alone and in combination, studies of the kinds and amounts of food consumed by individuals and groups, the relative value, from a money standpoint, of different foods and food combinations as sources of nutritive material, the effects of cooking upon nutritive value and digestibility, and related questions, as well as an investigation of the fundamental laws of nutrition and the practical application of these laws to the health and well-being of man. Particular attention is given in this work to the hygiene, physiology, pedagogics, and economics of nutrition, with special reference to securing data which will be of service in improving the diet of people of different age and sex living under varied conditions of occupation, climate, and surroundings, and to accumulating information for the use of teachers and students.

During the past year attention has been paid particularly to digestion experiments, cooking experiments, dietary studies, studies of the metabolism of ash constituents of food and the proportions required in the diet, and the pedagogics of nutrition. In addition to the experimental work a large amount of editorial work has been required for the calculation of the results of the experiments, for the preparation of experimental data for publication in technical and popular form, and in similar ways.

The cooperative investigations have been carried on at agricultural experiment stations, agricultural colleges, and other institutions in different parts of the country, the general purpose being to form centers of investigation for the study of practical problems at such

institutions as offer exceptional facilities and so systematizing the work that it can be carried on from year to year as a part of a consistent plan. Experience has shown that this method is very successful and that the returns are large for the sums invested. In considerable measure this is due to the generous support of the cooperating institutions. These have contributed in some cases money and in practically all cases the use of laboratories, chemicals, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance, so that the Department funds available for nutrition work have been materially extended. The value of association with the Department in such work is highly appreciated by the cooperating institutions, as is shown by their readiness to continue the work and by the numerous opportunities which arise for extending the work should Department funds permit.

THE WORK AT DIFFERENT PLACES.

The Washington office, in charge of Dr. C. F. Langworthy, has had the general supervision of the plans and expenditures of nutrition investigations during the past year, and, in cooperation with collaborators, has made detailed plans for the various experiments which have been undertaken. As in the past, editorial work has been an important feature, and has included the final preparation of reports for publication, and the preparation of popular bulletins and summaries. The collection of bibliographical data relating to nutrition has been continued, and also the preparation of abstracts and reviews of the current literature of the subject, partly for use in the Experiment Station Record and the series of Farmers' Bulletins entitled "Experiment Station Work," and partly for such other purposes as has seemed desirable in connection with the general inquiry. Many teachers, students, and specialists have been supplied by correspondence and in other ways with information and data which are not readily accessible in printed form, and data on nutrition have been collected at the request of Members of Congress and of different branches of the General Government. The increase in correspondence, the growing demand for nutrition publications, and the large number of requests for lectures and informal talks on the subject indicate that the popular interest in nutrition work is increasing markedly.

Under the immediate supervision of the Office a Farmers' Bulletin, based on experimental and practical studies, was prepared by Miss Maria Parloa on the cooking of vegetables. In a similar way investigations on household methods of canning vegetables have been conducted by Miss Isabel F. Hyams, of the Massachusetts Institute of Technology, and by Miss Charlotte Bragg, professor of chemistry

at Wellesley College, the object of this work being to secure data for a Farmers' Bulletin. A Yearbook article on "Fruit and Its Uses as Food" was prepared by C. F. Langworthy, as well as a report on the condition of nutrition investigations and similar articles.

Three dietary studies at homes for the aged and two at orphan asylums were undertaken by Doctor Langworthy and H. L. Knight, in cooperation with charitable institutions in Baltimore, Md., with a view to obtaining factors for use in determining the relative amounts of food required by the aged and by the young.

In cooperation with the Office, Miss Juniata L. Shepperd, of the College of Agriculture of the University of Minnesota, has prepared a summary of data on the ways in which the nutrition investigations carried on under the auspices of the Department of Agriculture are used by teachers of home economics, particularly in the agricultural colleges.

Prof. M. E. Jaffa and his associates at the University of California have continued their investigations on the digestibility of fruits and nuts and their nutritive value when forming an integral part of a mixed diet, as well as the effects of different amounts and combinations upon the utilization of these food products. Owing to the importance of the fruit and nut industry in California and the large variety of fruits and nuts obtainable in that section, the University of California is a particularly favorable place for such investigations and the work has met with cordial support. In carrying on his studies Professor Jaffa has made, during the fiscal year, twenty-five digestion experiments, which have also included studies of the income and outgo of nitrogen. As a whole, his investigations have shown that fruits and nuts are quite thoroughly digested and that they may be used as reasonably economical constituents of the diet even in large amounts.

The investigations carried on at Wesleyan University, Middletown, Conn., by Prof. F. G. Benedict and his associates, have had to do with the digestibility and food value of green curd and of American Cheddar cheese made with different amounts of rennet and cured for different lengths of time, the ease and rapidity of digestion of cheese, and the value of this food as a source of energy. In studying the question of energy, the Atwater-Benedict respiration calorimeter was used, as well as in investigations of the normal output of carbon dioxid and heat and the oxygen intake of the body under a variety of conditions. The Dairy Division of the Bureau of Animal Industry cooperated in the cheese investigations, having furnished the samples used and rendered material assistance in other ways.

In the 184 digestion experiments in which from 150 to 200 grams of cheese were taken per day with a basal ration of bread and fruit,

it was found that the cheese was uniformly very well assimilated, and no constipation or other physiological disturbances were observed. In general the investigations have shown that cheese can be consumed in liberal amounts by healthy individuals with no disturbance, and that this food material, which is reasonable in price, may be used to supply a large proportion of the protein of the diet when desirable. The experiments with the respiration calorimeter indicate that the energy of cheese is readily available for work, and that cheese does not differ materially from other common food materials as regards ease of digestion.

A technical bulletin was prepared for publication describing improvements which have been recently made in the respiration calorimeter, particularly devices for the direct determination of oxygen. It also includes a report of the results of eleven experiments on the metabolism of matter and energy.

Dr. Edmund C. Shorey, at the Hawaii Agricultural Experiment Station, has continued his studies of the nutritive value of native food products and his dietary studies with natives and other residents of Hawaii. Data on the subject of tropical dietetics is limited, and Doctor Shorey's investigations are regarded as an important contribution to the subject.

The investigations in charge of Prof. H. S. Grindley, at the University of Illinois, have, as heretofore, had to do with the changes brought about by cooking in the nutritive value, flavor, color, and texture of meat. This work has necessitated a study of the meat extractives and other constituents of raw and cooked meat, and of the bodies which produce the characteristic flavor of cooked meat. The investigations have been conducted under very favorable conditions. The university has supplied an especially well-equipped laboratory for the work, and in addition has contributed in other ways. The meat used has been supplied free of cost by the Illinois Experiment Station from animals bred, grown, and fattened under known conditions. The department of household science of the university has also rendered valuable assistance. During the past year thirty-five cooking experiments have been made. In general the investigations have shown that it is possible to so control conditions that meat may be uniformly roasted to any desirable degree, from very rare to very well done, and the methods can be readily followed in the household. The flavor of roasted meat is largely due to the browning of the meat extractives. The inevitable loss sustained when meat is roasted is due largely to the evaporation of water and the removal of fat which melts and runs out into the pan.

Special attention has also been given to formulating the results which have been obtained in the meat investigations so that they may

be of use to teachers of home economics in agricultural colleges and other educational institutions.

At the University of Chicago Miss Edna Day has been studying by microscopical methods the comparative digestibility of raw and cooked starch when supplied by a variety of food materials under different conditions and related questions. As occasion has arisen the Office of Experiment Stations has cooperated in the planning of this work, the collection of data, and in other ways, and it is proposed to publish the results of the investigation in the form of a technical bulletin.

At the University of Maine and the Maine Agricultural Experiment Station, Director Charles D. Woods and L. H. Merrill have made digestion experiments, each of six days' duration, with different sorts of corn bread and other corn dishes made from different types of corn meal. In connection with this work special attention has been paid to the metabolic products of the feces and to the comparative economy of corn and wheat products as sources of nutrients and energy in the diet. As a whole, the investigations have shown that the corn bread and similar corn products have much the same digestibility as similar foods prepared from graham flour—that is, they are somewhat less thoroughly digested than standard patent flour bread. As a whole, however, they are reasonably inexpensive sources of nutritive material, wholesome and valuable for the variety they give to the diet.

Professor Woods and Prof. Harry Snyder, of the Minnesota Experiment Station, on the basis of their investigations on the digestibility and nutritive value of cereal breakfast foods, have prepared a farmers' bulletin, published early in the year, which summarized available information regarding the food value and place in the diet of this class of food materials.

The investigations on the nutritive value of flours and other cereal foods, carried on at the University of Minnesota and the Minnesota Agricultural Experiment Station under Prof. Harry Snyder's direction, are similar in scope to those made at the University of Maine, the investigations being so planned that the work at each institution supplements that at the other, and the two together cover the broad field of the nutritive value of cereal foods as a class. Professor Snyder has made twenty-four digestion experiments of four days' duration, each with men, using crackers, cookies, and other cakes, and similar foods, with a view to determining the digestibility of flour in other forms than bread when forming an integral part of a simple mixed diet. The investigations have shown on an average that the various flour products tested differ little as regards thoroughness of digestion from bread baked from standard patent flour. In other words, they are directly comparable as sources of

nutrients and energy with white bread. As yet the question of relative ease of digestion and related topics has not been considered in connection with these food products.

The principal features of the work on the ash constituents of food, at Columbia University, New York, by Prof. H. C. Sherman and his associates, have been studies of the balance of income and outgo of iron, calcium, magnesium, phosphorus, and nitrogen; dietary studies with special reference to iron and the possibilities of increasing the iron content of the diet when desirable without the use of expensive foods, and estimates of the amounts of iron furnished in typical dietaries. A bulletin reporting this work has been prepared for publication.

At Teachers' College, Columbia University, Miss L. H. Stimson, under the direction of Miss Helen Kinne, has made a study of the culinary qualities of old-fashioned and new-process corn meal and has summarized data on the nutritive value and uses of corn meal and other corn products.

The results of investigations carried on by Prof. C. E. Wait, of the University of Tennessee, have been prepared for publication in two bulletins, one giving the results of an extended series of investigations on the digestibility and nutritive value of dried beans, peas, and cowpeas, and the other the results of dietary studies of families living in the mountain regions of Tennessee. The work with dried legumes is particularly interesting and valuable, as it demonstrates that these foods when well prepared are very thoroughly assimilated, and are economical and valuable sources of nutritive material, especially protein. The high nutritive value of beans and peas is quite generally conceded, but the cowpea is little known in the United States as a food product outside of the regions where it is grown, and Professor Wait's investigations, when rightly understood, can hardly fail to increase the demand for this typical southern food product in regions where it has hitherto been unknown.

PUBLICATIONS.

During the past year the food and nutrition publications issued have included three technical bulletins, three Farmers' Bulletins, a Yearbook article, and special articles and general summaries for the Annual Report of the Office of Experiment Stations and similar reports. The subjects treated in these publications are as follows: Studies on the Digestibility and Nutritive Value of Bread and of Macaroni at the University of Minnesota, 1903–1905; A Digest of Japanese Investigations on the Nutrition of Man; Studies on the Influence of Cooking upon the Nutritive Value of Meats at the University of Illinois, 1903–1904; The Guinea Fowl and Its Use as

Food; Cereal Breakfast Foods; Preparation of Vegetables for the Table, and Fruit and Its Uses as Food.

In addition two Farmers' Bulletins and one circular were extensively revised.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

The organization of Irrigation and Drainage Investigations carried on under this Office has been somewhat centralized during the past year, a larger part of the work being directed from the Washington office. The work has continued under the general direction of Dr. Elwood Mead, with C. G. Elliott as chief drainage engineer and R. P. Teele in charge of the publications. Professor Fortier is in charge of the Berkeley office and of the work in California. The Cheyenne office is maintained as headquarters for the work in irrigation extension in the semiarid regions, under the charge of F. W. Roeding.

IRRIGATION.

In planning the work for the season of 1906 it was decided that the work at all of the stations where investigations were being made should cover certain general lines so far as possible, and that in the future our publications should take the character of manuals upon certain phases of irrigation practice and reports on irrigation conditions and practice in particular localities rather than annual progress reports.

Measurements of the quantity of water used by irrigators were made on Stoney Creek, Cache Creek, and in the Imperial Valley in California; under a number of canals in the State of Nevada; in the Wallawalla and Umatilla valleys in Oregon; at Twin Falls and Idaho Falls in Idaho; on the Weber River in Utah, and in the North Platte Valley in Nebraska. In Oregon, Utah, and in the Imperial Valley in California these measurements included records of the water turned into the canals as well as independent measurements of the water turned on to particular fields, the aim being to determine (1) the duty of water with the losses from seepage and evaporation in canals added, and (2) duty of water with all losses except those from evaporation and seepage in the fields eliminated. The measurements in these last-named sections were requested by State authorities as an aid in the proper settlement of water rights.

The measurements in other localities were made to obtain data needed in perfecting a system of distributing water from canals among farmers. The great problem of irrigation in the West is to increase the duty of water. The ultimate acreage which will be reclaimed depends upon this. The quantity of water flowing in western streams can not be increased, but the acres which these

streams will irrigate can be extended by more skillful methods of handling. So long as crop yields are not diminished, the greater the economy in the use of water, the greater the value of streams, and the greater the value of canals that distribute streams, but there is a point where economy in the use of water cuts down the yield of crops and then the increased value of the streams stops because of lessened production and value of land.

The work of this Office is to determine the methods by which the ultimate limits of profitable economy can be reached. During the past year the advanced work along this line has been of two classes: (1) An attempt to determine the exact amount of water used by plants in the processes of growth, and (2) an attempt to determine what are the limits of profitable economy in the use of water in the ordinary field practice where the necessities of plants and certain inevitable losses from seepage and evaporation must be provided for.

Work of the first class was carried on chiefly in California, and that of the second class principally in Utah. The work in both California and Utah was carried on in cooperation with the State and the State experiment stations. In both cases arrangements were made with irrigators in certain selected areas, who used water according to schedules approved by the Office, or where the water used was measured by the representatives of this Office. These experiments promise to give very valuable data as to the water requirements of crops.

These measurements, like those of former years, show that in many cases half the water turned into canals is lost in transportation. Earthen canals are not impervious. The bottoms of many leak like a sieve. Water has now become so valuable and the injury from seepage water so serious that some practical method of lessening the leakage from canals will be of great value to irrigated agriculture. In 1906 the Office cooperated with the State Experiment Station of California in some comprehensive tests of canal linings which included cement, crude oil, and clay. The Office carried on similar experiments in Oregon with oil, lime, manure, and other substances. The results of one year do not give sufficient information on which to base definite recommendations, and these will be continued the present season.

Any method of practice which will lessen the water surface exposed to the action of the air or restrict the time when a water-soaked soil is exposed to the sun and wind will add to the area which a given quantity of water will irrigate. Some of the experiments in California were made to determine how much water could be saved through applying the water below the surface or applying it in deep and narrow channels where the wetted surface would be covered with

a mulch of dry soil immediately after irrigation ceases. To avoid the uncertainties due to seepage losses, these experiments were carried on in tanks 3 feet deep. It is found that in some instances the losses would be decreased as much as 50 per cent, the saving being equal to 10 to 20 per cent of the quantity applied. If these results could be duplicated in field practice they would make it possible to increase the area irrigated by an equal percentage, and it is believed they can be in the irrigation of orchards. The principles underlying this saving can be applied in modifying the methods of irrigating grain and hay. The corrugated system of irrigation applied to the irrigation of grain and hay fields in Washington, for example, requires less water and produces larger yields than the plan of flooding the entire surface.

At Canyon City and Rockyford, Colo., demonstrations of the value of irrigation through deep furrows and immediate covering of the wetted surface after irrigation, added to clean and frequent cultivations of the soil, was carried on, the results being very favorable to the decrease of water and the increase of cultivation.

Great activity in the settlement of the semiarid region within the last few years and the repeated failure of similar earlier attempts at settlement have made necessary a study of the irrigation possibilities of this region. It is believed that only by making use of all the water which can be secured by storing storm water and pumping from wells for irrigation can a repetition of the earlier experiences be prevented. We have, therefore, devoted a considerable part of our funds to what has been termed "irrigation extension" work. A farm was established at Cheyenne, Wyo., part of which has been irrigated only in the previous autumn when flood water was available, and part irrigated during the summer with water pumped from wells, and a part farmed without any irrigation. On this single farm it is possible therefore to compare the possibilities of flood-water irrigation, summer irrigation from wells, and intensive cultivation to conserve rainfall. The results in 1906 were most encouraging, large crops being harvested from both the flood-irrigated and the summer-irrigated fields and good crops from lands not irrigated. A similar farm where all the water used was pumped from wells was established in Chase County, Nebr., and farms were also maintained at Wichita Falls and Quanah, Tex. In addition to conducting these farms information was collected as to what has already been done in the way of irrigation from small water supplies throughout eastern Colorado. This study consisted in a mere collection of information as to equipment, cost, and areas irrigated. In Wyoming, South Dakota, and Montana a more thorough study of small storage was made. In that section a number of small reservoirs have been made,

some of which are used exclusively for stock water and some of which are used for irrigation. Full information as to plans of dams, methods of construction, cost, and returns from the use of water was collected and has been published. Many of these reservoirs are built in drainage channels which carry water only during storms, and indicate that there are great possibilities of extending the irrigable area in the semiarid region by this means. Where such stored water has been used for raising winter feed for stock it has been found that winter range losses, which ordinarily amount to about 10 per cent, have been practically eliminated, in many cases paying the entire cost of construction in a single season, while the fresh vegetables and fruit have not only added greatly to the comfort of ranch life but have helped to solve the problem of keeping farm help, since it is much easier to keep help where fresh food is available. The demand for information has become so great that it is deemed advisable to establish farms in other localities to serve both for determining the possibilities of this class of irrigation and as demonstrations to settlers who are pouring into the semiarid region from unirrigated sections, of the methods which should be followed in securing a water supply, and in putting it to use. It is planned to establish such farms at Eads and Limon, Colo., and Newcastle, Wyo.

As a further aid to beginners in irrigation the agents of this Office have, wherever possible, given personal advice to new settlers. It is recognized, however, that it is not possible to reach any great number of people by this personal method, and an especial effort has been made to bring together in the form of a manual all that the settler from the humid regions coming into an irrigated section needs to direct him in his work under the new conditions. A previous bulletin covering these subjects has been revised and a Farmers' Bulletin giving this information has been issued and very widely distributed.

The measurements of the quantities of water used in the irrigation of rice, which have been carried on for several years, were continued in 1906.

A very large part of the water used in irrigation in the semiarid region must be pumped from wells; in many sections of the arid region further extension of the irrigated areas will depend on pumping, while in the rice districts nearly all the water used is pumped. There is, therefore, an increasing demand for information regarding types of pumps and engines and their cost and efficiency. A large number of tests have been made in California and Louisiana during the past year to determine these points, the results having been published in two bulletins. These will be followed by popular bulletins giving such information as will enable farmers to secure the right kind of machinery and operate it properly.

Of great importance to irrigators who depend on pumping for their water supply, and in general to those who apply power to farm work, have been the tests of the power value of denatured alcohol carried on by this Office in the mechanical engineering laboratories of Columbia University, under the direction of Prof. C. E. Lucke of that university, and Prof. S. M. Woodward of this Office. These experiments in the use of alcohol are of great importance to the farmer not only because of its adaptation to his needs for power, but also because the production of alcohol may open up a market for many farm products now either unsalable or which can be cultivated for this purpose at a profit.

The study of effects of irrigation laws, public administrative systems, and ditch regulations upon the economical use of water has been continued during the year. This has been one of the most valuable lines of work done by this Office. Since its beginning seven States and Territories have adopted either whole or partial codes of irrigation laws correcting, as far as possible, the evils pointed out in our reports, and three other States have appointed commissions to draft such codes. The reports of this Office have not only shown the lack of harmony between existing law and the public interest, but have pointed out the lines upon which new legislation should be cast, and the new codes without exception follow these suggestions. Canal companies have revised the rules under which they distribute water, bringing them into harmony with the demands of the industry and in this way promoting economy in water.

It should be borne in mind that agricultural development in the arid region is absolutely limited by the water supply, and that every saving of water makes possible a proportional increase in the area reclaimed. Every line of work followed in the irrigation investigations of this Office has for its ultimate object this one thing—the largest possible use of the water supply, which by nature is limited in quantity. The carrying out of experiments and the making of investigations are necessarily local and as a rule benefit the localities where the work is done. But these benefits are only incidental. The larger benefit comes to the country as a whole from a better use of the resources on which the whole economic life of one-third the area of the United States rests.

DRAINAGE.

The drainage work of this Office covers two general fields: (1) The wet lands in the arid region, which have been injured by seepage water from canals and irrigated lands, and by the accumulation of alkali which usually attends the rise of the ground water with irrigation; (2) lands in the humid region which are too wet for agri-

cultural use, either from insufficient natural drainage, from overflow of streams, or from flooding by tide waters.

A few years ago this Office made plans for the drainage of lands at Fresno, Cal., which had been injured by the rise of the ground water. The plans recommended contemplated the organization of the district and the construction of large drains to relieve the whole area. Landowners have not, however, been able to come together for the carrying out of these plans, and experiments are being carried on to determine what can be done by individual landowners in draining small areas, even if general plans for the drainage of the whole area are not carried out. The plan recommended is to put in drains leading to a sump, from which the water is to be pumped into the irrigating canal or shallow surface drains and carried away. Similar experiments are being made at Turlock, Cal., where the rise of ground water is already threatening the ruin of the lands which have been irrigated only a few years.

Large areas in practically all of the irrigated valleys in Utah are suffering from overirrigation and the accumulation of alkali. Experiments are being made in a number of the valleys to determine the best methods of relieving these lands of the surplus water and the alkali. Experiments in Cache and Emery counties have demonstrated that lands in those sections can be profitably drained. The first experiments in Washington County have been only partially successful, but will be continued with such changes as experience has suggested. Four other experiments in different counties are not completed.

The Yakima Valley in Washington also contains large areas once fertile which have become too wet for cultivation. During 1906 an investigation and surveys were made in the Moxee Valley along this river, and plans made for the drainage of 4,500 acres of such lands.

Along the Colville River in Washington there are considerable areas of overflowed lands. Surveys to determine the feasibility of protecting these from overflow were made during the past season. The area affected is 16,500 acres.

At Lexington, Nebr., lands in the valley of the Platte River are suffering from an accumulation of drainage water from the higher lands and the rise of alkali. In 1905 plans were made for the drainage of about 30 acres of this land, and in the spring of 1906 the drains were put in in accordance with these plans. Observations to determine the effect of these drains will be continued for a number of years.

At Barstow, Tex., the irrigation of lands containing considerable quantities of alkali with water also containing alkali has brought about such an accumulation of alkali that the lands have ceased to

be productive. In 1906 observations of the rise of ground water were made and plans suggested for drains.

At Brownsville, Tex., the irrigation of rice for only a few seasons has brought about such an accumulation of salt in the soil that the industry has ceased to be profitable. Investigations have been made there to determine whether the providing of drains will permit the continuation of the raising of rice, which necessitates the saturation of the soil for considerable periods.

Surveys of the Red River Valley, in North Dakota, covering Cass, Traill, Grand Forks, Welsh, and Pembina counties, were begun in 1905 and completed in 1906. Plans for the main drainage of 1,500,000 acres in these counties have been made on the basis of the surveys. Many of the farms in this valley will require internal drainage, and it is a question whether tile drains will be successful for this purpose. At Fargo, N. Dak., and Crookston, Minn., parts of the State experiment farms are being supplied with tile drains for the purpose of determining whether they will be efficient where in the winter the ground freezes to depths of 5 or 6 feet.

The effectiveness of tile drains has not been demonstrated in the black gumbo and buckshot soils of river bottoms, and experiments are being made at Oswego, in the Neosho Valley, Kansas, and at Clover Hill, Miss., to determine this point. In both instances the surveys are made by this Office and the drains are to be put in by the landowners. Observations on the effectiveness of these drains are being made by the owners and reports will be made to this Office.

The bottom lands of the Neosho River, in Kansas, from Imperial to the State line were surveyed in 1906, for the making of plans for correcting the river channel to protect the bottom lands from overflow and to carry off the surplus water. The area of lands to be benefited by the work recommended is 200,000 acres.

Surveys were made of the Boggy Bayou in Arkansas to provide a drainage outlet for 135,000 acres, the run-off from which collects in a lake whose natural overflow outlet has been destroyed by the river-levee system.

Surveys in the valley of the Kankakee River in Indiana and Illinois, also begun in previous years, were completed in 1906. The upper part of this valley had previously been drained, and the work done in 1906 was to determine the necessary changes in the river channel to enable it to carry off the water from the upper valley and to determine a system of drains for the lower valley. The area to be benefited is approximately one-half million acres.

Surveys covering 200,000 acres in the Black Bayou in Mississippi have been made to determine the feasibility of draining this area and to make plans for this drainage if it seems feasible.

In Genesee and Orleans counties, in New York, general plans were made for the drainage of the Oak Orchard Swamp, covering about 10,000 acres.

For a number of years the Sanitary and Drainage Commission of Charleston County, S. C., has been draining the lowlands in the vicinity of the city of Charleston, but this work has been more or less fragmentary. During 1906 the cooperation of this Office in extending this work was asked, and surveys have been made covering an area of 36 square miles of Christ Church Parish and a part of St. Andrews Parish. The surveys in the latter parish are not yet completed. Plans were also made for the complete drainage of a 300-acre tract which may be used as a substation of the State experiment station.

For a number of years the drainage of the Florida Everglades has been under discussion, and the legislature of that State at its last session created a drainage commission to undertake the drainage of the State lands within the Everglades. This Office has been asked to assist in this work, and is making surveys to determine the feasibility of making and maintaining channels to relieve the Everglades of their surplus water. Along with these surveys observations of the depth of soil and other conditions which will determine the agricultural value of the lands drained are being made. The Everglades cover an area of 4,000 square miles, or 2,500,000 acres, which promise to be very valuable for the raising of sugar cane if they can be relieved of the surplus water.

The tidal marsh lands along the Atlantic coast are estimated to have an area of about 1,000,000 acres. Part of these lands are near large cities, and would have a very high value for market gardening and the raising of fruit if they could be protected from the invasion of salt water and relieved of the water draining onto them from higher lands. The reclamation of these lands requires the building of levees to protect them from the sea and the providing of internal drainage to remove the excess water coming from higher lands. The removal of this internal drainage water requires the construction of tide gates which will allow the escape of water at low tide and also the installation of pumping plants to remove the water below the level of low tide. Plans for the drainage of a small area of tide marshes on Long Island were made in 1906 and examinations of a number of levees which had failed were made to determine the causes of failure. A discussion of this subject is found on page 373.

The carrying out of drainage plans in most instances requires the cooperation of a number of landowners, and it has been found by experience that such cooperation can seldom be secured except under drainage-district laws providing for the organization of the land-

owners for the assessment of benefits and damages and for the levying of taxes to pay for the works. The drainage experts of this Office have rendered valuable assistance to State legislatures in securing laws which will successfully accomplish the objects sought.

PUBLICATIONS.

During the fiscal year ended June 30, 1906, there were printed three bulletins and one circular on irrigation and drainage. These contained 939 pages of new matter.

There were submitted for publication, but not printed during the fiscal year, five bulletins, one Farmers' Bulletin, and one circular.

PROMOTION OF AGRICULTURAL EDUCATION.

The rapid growth of agricultural education in colleges and schools and the rapid development of a sentiment favorable to the extension of agricultural features of instruction in all rural communities have been reflected in the increased demands made upon the Office of Experiment Stations for advice and assistance. The work of the Office in this connection has become so varied that it has been deemed best to divide the educational work into two sections. One of these deals with the agricultural colleges and schools, the other promotes the interests of the farmers' institutes and other forms of itinerant extension work in agriculture. In the appropriation act for this Department for the current fiscal year Congress provided for an investigation and report upon the organization and progress of agricultural schools in this country and abroad, but did not provide adequate funds for carrying on this work. Under such circumstances the educational work of the Office could not be developed in anyway proportional to the increasing demands for this work. Arrangements were made, however, to devote practically all of the time of the Expert in Agricultural Education, D. J. Crosby, to this work, and to give him some additional clerical assistance. In this way it has been possible to review the literature of agriculture and prepare 125 abstracts of important text-books, manuals, and other publications on this subject for the department of agricultural education in the Experiment Station Record, to assist in outlining courses of study for the Georgia and Maryland agricultural schools, to attend a number of important conventions, take part in conferences on agricultural education and lecture at teachers' institutes on elementary instruction in agriculture, and to complete a few publications on educational topics. The annual summary of the progress of agricultural education has been prepared and is included in this report (p. 213).

At the invitation of the committee on graduate study of the Association of American Agricultural Colleges and Experiment Stations, the Director of this Office acted as dean of the Graduate School of Agriculture which held its second session at the College of Agriculture of the University of Illinois in July, 1906, and was in every way successful. The number of students was larger than at the first session of the school and a larger number of specialists in agricultural education and research took part in the instruction and the conferences.

The land-grant colleges have had larger funds, more students, and more graduates than ever before, they have added materially to their general and agricultural equipment, they have made progress in the differentiation of agricultural instruction and the organization of faculties of agriculture, including special faculties for extension work, and several of them have undertaken well-defined work in the preparation of teachers of agriculture for secondary and primary schools.

Additional secondary schools of agriculture have been started in connection with agricultural colleges. Private and denominational colleges have begun to organize secondary courses in agriculture. A new agricultural high school has been started in Maryland and eleven have been provided for in Georgia, and many of the normal schools are organizing agricultural courses. Progress has also been made in the introduction of agriculture into the public secondary and elementary schools and in the preparation of text-books, manuals, courses of study, and other aids for teachers and pupils in agriculture.

Agricultural education is making friends everywhere. The President of the United States, the Secretary of Agriculture, the governors of several States, the presidents of some of the great universities, and other officials high in the councils of the nation have given public utterance during the year to their belief in the instruction of the masses of our rural people along agricultural lines. Numerous bills providing for additional Federal aid to agricultural education of different grades have been introduced at the second session of the Fifty-ninth Congress, and the State legislatures have given in several States large, and in many States substantial, aid to agricultural colleges and schools and to itinerant agricultural enterprises of educational nature. The Association of American Agricultural Colleges and Experiment Stations, the American Association of Farmers' Institute Workers, the National Grange, the National Farmers' Congress, and other large associations of educators and farmers have adopted resolutions declaring in unmistakable terms their belief in agricultural education, and their desire that it receive more

liberal support. And the newspapers and periodicals all over the country have given expression to public sentiment in these matters.

This Office is endeavoring to aid this movement as a general agency, cooperating with the other branches of this Department, the State agricultural colleges and experiment stations, and the State departments of agriculture and education. It is hoped that in this way it may be possible to incorporate speedily in courses of instruction in agriculture whatever useful results are obtained in the research work of the Department and stations, to bring the results of experience in agricultural education at home and abroad to bear on the problems connected with the development of a system of public education better adapted to the needs of our rural communities, and to enable the rural people throughout the country to understand what is required to make their schools more effective and to take proper measures for the enrichment of country life and the permanent prosperity of American agriculture.

FARMERS' INSTITUTES.

The Farmers' Institute Specialist has continued to aid the State directors by distributing literature, attending meetings of representative farmers, delivering addresses before farm organizations, aiding in the preparation of publications, perfecting the organization of the work of the Office, and conducting correspondence. During the year eleven States and the Province of Ontario were visited and twenty addresses were delivered. In addition to his annual report he prepared for the printer copy for the following publications: List of the State Directors of Farmers' Institutes and Farmers' Institute Lecturers; Legislation Relating to Farmers' Institutes in the United States; and Agricultural Instruction for Adults in Continental Countries. He also aided in the editing of the Proceedings of the Tenth Annual Meeting of the American Association of Farmers' Institute Workers, and the Course in Cheese Making for Movable Schools of Agriculture.

The Office is also cooperating with the Association of American Agricultural Colleges and Experiment Stations in conducting investigations for the purpose of ascertaining to what extent extension work in agriculture is being done by colleges, schools, State departments of agriculture and education, agricultural organizations, the press, and other agencies throughout the United States. The Farmers' Institute Specialist has been made secretary of the standing committee of the association and has conducted a large part of the correspondence relating to this investigation.[a]

[a] For a report of this committee see U. S. Dept. Agr., Office of Experiment Stations Circ. 72.

To supplement the farmers' institutes by providing more definite instruction on particular agricultural subjects the Office has undertaken the preparation of short courses of from ten to twenty lessons on a few selected topics especially adapted to different localities to be given under the direction of competent instructors. In pursuance of this policy a course in cheese making for movable schools of agriculture, prepared by L. L. Van Slyke, of the New York State Agricultural Experiment Station, consisting of fourteen lectures with references and a corresponding number of practice exercises, has been published as a bulletin of this Office, and arrangements have been made for the preparation of five other courses of a similar character. Great care is being exercised in the preparation of these courses to have them in proper pedagogic form. The difficulty of condensing the courses into comparatively few lectures, at the same time insuring their reasonably complete treatment, is partially overcome by the liberal use of references to literature which will furnish a selected course of collateral reading following each lecture and preceding each practice exercise. Such itinerant schools of instruction have proven very successful in several European countries, and it is believed that they can be made to serve a very useful purpose in this country in supplementing present agencies for the wider dissemination of agricultural knowledge.

The statistics of farmers' institutes in the United States as compiled by the Farmers' Institute Specialist are included in a report given on page 301. According to these statistics institutes are now organized in all of the States and in all of the Territories excepting Alaska. Institute meetings were held in all of the States excepting Florida, Nevada, and Washington and the Territory of New Mexico. The failure of the legislatures in these States and in this Territory to provide for the maintenance of the institutes accounts for their temporary discontinuance.

The total number of institutes held was 3,409 and the total number of sessions 11,409. The total attendance at these institutes was 1,299,172, an increase of 403,980 over the attendance of the previous year. The average number at each session was 114. The appropriations for institute purposes amounted to $269,672. Fifteen States reported round-up meetings, with an attendance of 24,598; 19 States held special institutes, attended by 85,762; 13 States reporting upon agricultural trains give an approximate attendance upon these trains of 215,890. The aggregate attendance for the year, including the regular institutes, the round-up meetings, special institutes, and railroad specials, was 1,625,422. The number of institute lecturers increased from 995 in 1905 to 1,225 in 1906. Of these 342 were sup-

plied by the agricultural colleges and experiment stations, and they contributed 3,119 days of time to lecture work.

The holding of examinations for farmer boys, with prizes admitting to the short course at the State agricultural college; peripatetic teachers of agriculture who visit rural schools and give instruction; railroad trains sent out as emergency specials; field demonstration meetings; the organization of agricultural sections in teachers' institutes; conducting stock and grain judging schools; the assignment of representatives of county school departments to participation in institute work, and the enlargement of schools of instruction for farmers' institute workers are some of the new features of progress in the institute work of 1906.

The Eleventh Annual Convention of the American Association of Farmers' Institute Workers was held in Baton Rouge, La., November 12–14, 1906, and was attended by 116 delegates representing 37 States and Territories and 4 of the Provinces of Canada. The proceedings of this convention have been published as a bulletin of this Office (see p. 310).

In order that the Office may be in position to act efficiently as a central rallying point and clearing house for the movement for wider diffusion of education among the masses of our rural population, it is necessary that the funds for its maintenance shall be largely increased. When this is done it will be possible to aid the State departments of agriculture and the agricultural colleges and experiment stations in increasing the efficiency not only of the farmers' institutes, but also of other forms of extension work in agricultural education which may be of value in connection with our educational system.

In order to do this there is needed a force of experts to devote themselves to the study of the pedagogical problems involved in agricultural extension work; to consult and cooperate with the State authorities and leaders in education; to prepare publications, charts, and illustrative material for use in extension work, and to make demonstrations of proper methods for such work before representative assemblies in the various States.

PUBLICATIONS.

The publications of the Office may be conveniently grouped in four main classes: (1) Experiment Station Record, which gives a technical review of the current literature of agricultural investigation throughout the world; Experiment Station Work, which is published periodically in the Farmers' Bulletin series of the Department and gives a popular summary of some of the more salient practical

results of the work of the experiment stations; and a monthly list of experiment station publications, which is now regularly published by the Office. (2) Publications relating to the food and nutrition of man, reporting or based upon the results of nutrition investigations conducted under the auspices of the Office. (3) Publications relating to irrigation and drainage, giving the results of the irrigation and drainage investigations of the Office. (4) Miscellaneous publications, including those relating to agricultural education in general, as well as farmers' institutes, proceedings of the Association of American Agricultural Colleges and Experiment Stations and of the American Association of Farmers' Institute Workers, annual reports of the Director of the Office of Experiment Stations, the Card Index of Experiment Station Literature, and similar publications.

During the past fiscal year the Office published 71 documents, not including revised reprints, separates, etc., aggregating 5,128 pages. These documents include 11 numbers of the Experiment Station Record, 1 bulletin of the Alaska Experiment Stations, 14 technical bulletins, 3 bulletins of the Porto Rico Experiment Station (English and Spanish editions), 5 bulletins of the Hawaii Station, 2 reports, 10 Farmers' Bulletins (including 6 numbers of the subseries Experiment Station Work), 5 circulars, and 5 articles for the Yearbook of the Department. Two other numbers of the Experiment Station Record, 6 technical bulletins, 1 report, 1 bulletin each of the Alaska and Hawaii stations, 2 Porto Rico Station bulletins, 1 Farmers' Bulletin, 1 circular, and several miscellaneous documents containing about 1,500 pages were prepared and submitted for publication before the close of the fiscal year. Copy for 1,200 cards of the index of experiment station literature was prepared during the year. The number of index cards distributed has reached 26,900. The amount received from the sale of index cards during the year was $195.97. The policy of reprinting separates of individual articles contained in larger reports has been continued with satisfactory results. Thirty-three such separates, aggregating 1,269 pages, have been reprinted in editions of varying size to meet the actual demands for the articles. Several of the earlier technical and Farmers' Bulletins of the Office were exhausted during the year and were reprinted, in many cases with complete revision or more or less additions and corrections. Eleven of the earlier numbers of the Experiment Station Record were reprinted in limited editions to complete sets.

The report of the Department Editor for 1906 shows that 2,304,750 copies of the publications of this Office were issued during the past fiscal year, of which 2,025,000 were Farmers' Bulletins.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office (including farmers' institutes)	$55,700
For the Alaska Experiment stations	18,000
For the Hawaii Experiment Station	15,000
For the Porto Rico Experiment Station	15,000
For nutrition investigations	20,000
For irrigation and drainage investigations	74,200
Total	197,900

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

By A. C. True and E. W. Allen.

The year 1905–6 was one of unusual activity among the experiment stations. The increased State appropriations received by several of the stations provided for the enlargement of their work and the introduction of new features, and the passage of the Adams Act increasing the Federal appropriation necessitated a large amount of preliminary work in the way of perfecting plans, adjusting the working force, providing facilities, etc.

The passage of this act was not only the most important event of the year to the experiment stations, but was the most significant and far-reaching event of any year since the stations were established. It marks a distinct era in the life of the stations and in agricultural investigation. It not only provides increased funds for the station work, but it stipulates that this shall be of advanced character. It has served to draw attention sharply to a consideration of what constitutes scientific research in agriculture as distinguished from the mere acquisition of empirical knowledge. The result has been a general uplift in the conception of the duties and responsibilities of the stations, and a stimulation of activity in all the more advanced lines of investigation. The stations were in great need of additional funds for the development of their work to meet the popular demands upon them; but the most imperative need of agriculture was for research of a thorough and fundamental character, to lay the foundation for intelligent and improved practice. The activities of the stations had led up to this and had made it imperative if the stations were to keep abreast of the demands upon them.

An inevitable result has been the setting of a higher standard of qualifications in station workers, a more general realization of the prime importance of the worker in investigation, and the necessity of a broad and thorough scientific training as preparation for this work. It is now realized as never before in the history of the stations that the first requirement is for well-trained men capable of planning and successfully carrying on the work of the various departments; and as the supply of men with such qualifications was considerably below the demand, there was a considerable shifting of

men from one station to another when the new departments came to be organized. A larger number of men thoroughly trained as agricultural investigators is the greatest need of agricultural investigation to-day, and the provision for this advanced work which has been made by the Adams Act will stimulate men to prepare themselves for this field of activity.

One of the tendencies of recent years has been to restrict the instruction given by the station force to a small amount, leaving them free to devote their best energies to experiments and investigation. In several instances there has been a movement toward providing a practically separate staff for the station work, whose members should be either entirely free from teaching or only called upon for a small amount of advanced instruction. This tendency has been increased by the passage of the Adams Act and the provision for a larger amount of research, for it is recognized as impracticable for a man to carry on the two kinds of work with equal efficiency. For administrative reasons, also, the provision of a force of men whose duties are primarily connected with the station is often an advantage. The time is past when the needs of the station work can be satisfied by consulting experts or those who give only fragments of time to it, and with the increased appropriations which are now being received from the General Government and from the States, there seems every reason why the station work should be organized on the basis of the greatest efficiency, irrespective of the instruction work of the college.

PROGRESS OF THE STATIONS.

The States as well as the General Government have recognized the increasing importance of the station work and its local value. This is evidenced by increasing special appropriations for maintenance and by liberal appropriations for buildings.

The New Jersey Station was placed in charge of an appropriation of $350,000 for work looking toward the extermination of the mosquito, and in Kentucky a feed-inspection law went into operation which, it is expected, will yield the station about $15,000 a year. In Illinois, where the station has received $95,000 a year for several years, the amount was increased by $10,000. In Iowa over $30,000 was given, mainly for extension of the dairy and live-stock work. The Ohio Station received $106,900 for the biennial period; the Minnesota Station, $37,000; Nebraska, $20,000; Missouri, $15,000, and Utah, $21,000. In Maryland the annual appropriation was increased from $5,000 to $10,000, and $4,000 was given for horticultural experiments. In all, the stations received from the States and other sources than the Federal appropriation a total of $1,057,492.12, making the grand total from State and Federal sources $2,017,492.12.

Agricultural buildings, to be used by both the colleges and the stations, were either appropriated for or completed during the past year in Idaho, Iowa, Minnesota, New York, Oklahoma, Vermont, and Virginia. The Iowa building is expected to cost when completed $275,000. The Cornell building is being constructed in parts, with a State appropriation of $300,000. A considerable number of other buildings for special departments were also provided. Among these are a horticultural hall in Kansas, a chemical building in North Dakota costing $48,000, a dairy building in Mississippi, a $40,000 building for the botanical department in Massachusetts, cattle and hog barns and a farm mechanics building in Missouri, and an insectary in Minnesota.

The Florida Station was moved during the year to its new location at Gainesville, and although this has involved some temporary interruption of the station work, it is believed that its new plan of work will eventually prove of greater benefit to the varied agricultural interests of the State. In California a farm has been acquired in the Sacramento Valley, which will be used by the college and station jointly, adding quite materially to the facilities of the station. The main building of the University of Idaho was destroyed in the spring of 1906, and with it the offices, laboratories, collections, and library of the station. A new agricultural building is in process of erection, which will afford improved facilities for the station.

The additions to the equipment of the stations in 1906 included buildings valued at nearly $170,000, and amounted in the total to approximately $347,000.

SOME FEATURES OF STATION WORK.

The breeding of plants for improvement in quality or yield, for adaptation, resistance to disease and drought, and for various other purposes continues to occupy much attention. The results of this work have aroused popular interest in it, and it is looked to as a means not only of raising the quality and yield, but of extending farming in the drier regions and of adapting special crops to new localities.

The improvement of seed corn by selection and by greater attention to general quality has resulted in great benefit in the corn-growing regions, and out of it has grown a widespread interest in breeding for some special qualities. The work has spread to a great variety of other crops and caused attention to be given to the kind of seed used.

The breeding work has also taken account of the use to be made of the crop, its suitability, and its adaptability to the demands of the market. This has led to studies of the milling and baking qualities

of wheat, for which miniature flour mills and bakeries have been installed, to the making of macaroni from durum wheats, and the like. The use of sweet potatoes for starch making and tests of the special qualities of the product, studies of the drying of hops for the market, and the making of sugar from specially bred cane are other examples of this technological investigation which is becoming a conspicuous feature of station work. This is simply in pursuance of the logical contention that a broad conception of agricultural investigation and of the means of advancing agricultural interests involves a consideration of the best utilization of farm products, as well as the most efficient and economical methods of production.

In connection with the most important feature of agricultural technology, namely, dairying, there has been much progress during the past year in improving the sanitary condition of market milk, in determining the practicability of the milking machine, in the American manufacture of Camembert and Roquefort types of cheese, which are now extensively imported from abroad, and in demonstrating the value of cold storage for cheese, especially as applied to products which would otherwise be of a very low grade. The Wisconsin Station has demonstrated the practicability of recovering the fat from whey at Swiss cheese factories as whey butter, the practice of which would add $150,000 a year to the value of dairy products in that State alone.

The extension of the area of general agriculture or of special crops is also a notable feature of station work. The development of dry farming has received a great impetus in recent years, and the commercial features of this development have been much in evidence. The stations have had a very active part in working out the crops and culture methods for these dry areas, and have been supported by State appropriations which have enabled them to maintain many branch farms and demonstration fields. Their work is undoubtedly contributing in large measure to a safe and sane solution of arid farming, which is fraught with grave danger to the uninformed settler.

The date-palm orchard in Arizona, in cooperation with the Bureau of Plant Industry, yielded a crop of about 3,000 pounds of dates this year, which were pronounced of excellent quality.

The Arkansas Station has demonstrated that as far north as the central portion of the State rice can be grown with success on prairie lands under irrigation. Stands of alfalfa and red clover are now secured in many localities of the Northwest where prior to station investigations upon the subject efforts to grow these crops were generally regarded as useless. The area of successful culture of alfalfa has also been largely extended in the East. In Oklahoma,

where Bermuda grass grown from seed is a failure, the station has selected hardy strains of this plant and has worked out an easy method of propagating it by means of sod planting.

The improvement of tobacco by breeding, its culture, and its curing are receiving attention from a number of stations, with noteworthy results. A new method of corn culture, which diminishes the size of the stalk by stunting the growth in the early stages by withholding cultivation and fertilizers, has been tested with success by several of the stations in the South. Under certain conditions the method appears to give increased yields of corn, with much less fodder.

The large amount of attention to problems relating to the soil and to soil fertility is one of the newer developments in station work. This work is not confined to systems of management, rotations, culture, and the economical use of fertilizers, but extends to fundamental studies of such factors as humus, humus formation, the biology of the soil, the agency of micro-organisms in rendering materials available to plants, the associative action of these organisms, and a variety of other questions of first importance to a clearer understanding of this great subject. In several States appropriations have been made for soil surveys, including a study of the soil types. These studies are usually supplemented by field experiments to determine the methods of improvement, carried out on various soil types and in pot cultures at the station. Closely related to this work is the study of inoculation for legumes, which has been in progress for some time and is continued to learn more about the conditions of inoculation and the cultures, the effect of nitrogen assimilation upon the composition and growth of the plant, and a variety of other questions.

The concerted action throughout the Southern States under the cooperation of the Bureau of Animal Industry and with a Federal appropriation, looking to the eradication of the tick transmitting Texas fever, is a very important development in its practical and scientific aspects. This effort grew in large measure out of the initiative of the stations in working out methods for successful eradication and in arousing public interest in the matter. The stations are taking an active part in this work and are contributing by their laboratory studies of the tick's habits, as well as by assistance in actual eradication.

The year has been marked by increased attention on the part of the stations to the scientific study of farm sanitation in farmhouse, stable, and dairy, and there has been further growth of the tendency toward the development of more advanced studies of the fundamental principles of the nutrition of farm animals, as exemplified probably in their highest form in work with the respiration calorimeter.

The amount of work done over the several States is constantly increasing. A part of this is through branch stations maintained by State appropriation, a part through temporary stations, and a great deal through direct cooperation with farmers. In Illinois investigations on soil fertility problems are conducted at no less than 25 places. The Indiana Station carries on cooperative experiments with over 700 farmers, representing each of its 92 counties. In Missouri corn improvement work is conducted with over 100 farmers, and in Nebraska there is cooperative work with about 1,800 farmers. In all the States the stations are working in direct contact with their constituents and are having a great influence on the improvement of their practice.

DISSEMINATION OF INFORMATION.

During the year the stations published 418 circulars and bulletins, and 45 annual reports, aggregating 17,501 pages, and amounting to 3,000,000 copies. In addition to this, a large number of more fugitive publications were issued, popular articles prepared for farm papers, and the like. The stations, as a rule, report rapidly growing mailing lists and increasing correspondence, and in some cases the demands of this nature have been more than they could meet. The publications of the stations are widely referred to in the agricultural press and in modern books on agricultural topics, so that the station work as a whole is being given wide publicity and is exerting a widespread and potent influence.

The special train continues to be an important means of reaching the farmer and teaching better methods. This has been operated extensively in the Middle Western States for several years, notably in Illinois, Indiana, Iowa, Kansas, and Nebraska, and during the last year or two has been introduced in the East, in Maryland and in New England. The popularity of these trains has been as great in the East as in the West, and the results probably equally important.

But to adequately provide for the wider dissemination of information among the farming people and the introduction of improved methods, earnest efforts are being made to establish agricultural extension work, organized as a special branch of the agricultural work and on such a basis as to relieve the stations of much of the burden which now rests upon them. This extension work is recognized as strictly educational in character, and hence not coming properly within the scope of the station when carried on systematically; and its grade and methods differentiate it from that of the college work proper.

In Iowa an extension department has been organized under a State appropriation and is in active operation. It has a corps of

workers of its own and supplements the work of both the college and the station, extending the influence of both. Such a department can render the work of a station more efficient by relieving it of certain miscellaneous duties, and make it more effective by carrying the results directly to the farmer.

STATISTICS OF THE STATIONS.

Each of the States and Territories, including Alaska, Hawaii, and Porto Rico, has at least one experiment station receiving Federal aid. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds or by private contributions. A number of substations or branch stations are also maintained in several States. Excluding the substations, there are now 60 stations in the United States, 55 of which receive appropriations provided for by acts of Congress. These stations have in their employ 950 administrative officers and scientific workers.

The total income of the stations maintained under the act of 1887 during 1906 was $2,017,492.12, of which $960,000 was received from the National Government, and the remainder, $1,057,492.12, from State governments, individuals, and communities, fees for analyses of fertilizers, sales of farm products, and miscellaneous sources. In addition to this, the Office of Experiment Stations had an appropriation of $197,900 for the past fiscal year, including $18,000 for the Alaska experiment stations, $15,000 for the Hawaii Experiment Station, $15,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, $74,200 for irrigation and drainage investigations, and $5,000 for farmers' institutes.

INSPECTION OF THE STATIONS.

The inspection of the operations of the experiment stations has continued to be one of the most important features of the work of the Office. In this the Office represents the Department in the general administration of the funds given by the Federal Government, and seeks to promote the work of the stations in a broad way.

The inspection is of broader character than the term would imply. It is not confined to an examination of the accounts and a scrutiny of the financial reports, but extends to the various activities of the stations and to their relations to other agencies in the State. This diversity is practically necessitated by the terms of the law which places the general supervision of the stations in the hands of the Secretary of Agriculture. This stipulates that in addition to prescribing the form and detail in which the expenditures shall be

reported, he shall "ascertain whether the expenditures under the appropriation * * * are in accordance with the provisions of the said act" (the Hatch Act), and shall make a report upon these matters to Congress.

The determination of the legality of the expenditures involves a consideration of the whole business and work of the stations, their efficiency, relations, and general influence, for no fixed rules can be laid down as to the kinds of supplies which may be purchased, the amounts which may be spent for salaries, for administration, for labor, for heat and light, and other expenses of maintenance. These are all incidental to the carrying out of the purposes of the act, and hence the determination of whether these purposes are being realized requires the general consideration of the administration, the work, and the influence of the stations in each individual case. A station might comply with the letter of the law so far as its expenditures were concerned, and its work still be of a negative value, and hence the kind and amount of work in progress, the methods of procedure, and the results which are being obtained are gone over in considerable detail on the occasion of the annual visits to the stations.

The relation of the stations to the colleges of agriculture with which they are connected also receives careful attention, especially the division of salaries of station men who are also instructors in the college, the purchase of equipment, maintenance of buildings, live stock, farms, orchards, etc. The prime functions of the colleges and the stations are distinct, and each have appropriations especially for their benefit. Although the operations of these institutions necessarily run into each other and overlap to a considerable extent, it is found feasible and practicable to separate the legitimate expenses of each class so that the Federal funds of the stations will be used exclusively for station work, and not in the general maintenance of facilities for teaching. Great progress has been made in this differentiation and the attitude of the colleges is very generally liberal.

There are numerous adjustments between the colleges and the stations which could not be insisted upon under the law, but have to be brought about by an appeal to good policy and the interests involved; and these things are obviously best accomplished through personal conferences. A very material change of attitude has been effected in numerous instances, which is working to the advantage of the stations in greater liberality or a more favorable arrangement of teaching duties or in other ways.

Another point of inquiry is as to the inspection work of various kinds which is assigned to the stations by State laws. This inspection includes a great variety of materials such as foods, feeding stuffs, fertilizers, insecticides, paints, nursery stock, seeds, etc. It has a rather intimate relation to the general functions of the stations,

and it is often an advantage to the stations in that it helps to bring them into closer relations with the farmers and to establish them more firmly as agencies for their protection from fraud, as well as for the working out of their agricultural problems. But since this service is purely State police work, the Department has held that the Federal funds should not be used for it, and that it must be so organized as not to interrupt or interfere with the activity of the stations in their more legitimate field. As the States have not always made adequate provision for this inspection work, the relation of the stations to it has required quite constant attention.

The position which the stations occupy leads them to be called upon for a variety of other services not within their legitimate domain, and the restrictions placed about the Federal funds by the Department have served to hold these demands in check. The attempt is made, while taking a broad view of the functions of the stations under the Hatch Act, to see that their funds, as far as the Federal appropriations are concerned, are restricted quite closely to expenses directly connected with the work of experimentation and investigation and the dissemination of the results. The Hatch Act is so broad in its language that without a quite close construction the funds might readily be dissipated for a variety of work, undoubtedly useful to the people, but which would in a large measure prevent the stations from realizing their true function. While the Department's construction has not been free from objection, its position is now generally recognized and has helped greatly in convincing the States that they must assume the burden of certain kinds of work.

In a general way the inspection of the stations is going on throughout the year. The annual visitation is the most important means of keeping informed as to the station work and business, general condition and progress, plans for the future, and the like; but there is steady correspondence with the stations throughout the year upon matters of policy, progress of work, use of funds, etc. And at the end of the year the financial reports are carefully examined in the light of the inspection reports and other data. This examination involves a considerable amount of work, as it can not be assigned to a purely clerical force, and requires much correspondence in order that the approval or disallowances may be made on an intelligent basis. But taken in connection with the general attitude of the Department, it has prevented dissipation of the Federal funds and has resulted in a steady development of the stations in point of efficiency, grade of work, and concentration of effort. The wisdom and advantage of this are now recognized by station officers and workers generally, who have found in the Office a champion of their cause and a promoter and defender of their highest interests.

In another capacity the Office serves as a central agency of the stations, being in advisory relations with them to a constantly increasing extent. This is promoted by its broad knowledge of the general conditions in the States, the trend of development in relation to agricultural experimentation and education, and the needs of this work. It has stimulated State appropriations to supplement Federal funds, especially for practical demonstrations, the application of known facts to local conditions, the maintenance of branch stations, and the like. It has set up a high standard for the station work, has urged the provision of improved facilities for that work, and pointed out the requirement for thoroughly trained men on the station staffs. On account of its acquaintance with the station workers as a whole, and with the character of their work apart from that which had reached publication, it has been able to offer much assistance to stations in recruiting their forces with men adapted to their needs.

In its relations with the stations, therefore, the Office lays quite as much stress upon stimulating the stations to develop along lines of increasing efficiency and usefulness as it does upon the inspection of their funds to guard against their being diverted from proper uses. Its functions in this respect were given increased importance by the passage of the act of March 16, 1906 (popularly known as the Adams Act), which also conferred upon the Department larger authority in the administration of the funds appropriated.

THE ADAMS ACT.

The text of the Adams Act is as follows:

AN ACT To provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditure thereof.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, to be paid as hereinafter provided, to each State and Territory, for the more complete endowment and maintenance of agricultural experiment stations now established or which may hereafter be established in accordance with the act of Congress approved March second, eighteen hundred and eighty-seven, the sum of five thousand dollars in addition to the sum named in said act for the year ending June thirtieth, nineteen hundred and six, and an annual increase of the amount of such appropriation thereafter for five years by an additional sum of two thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be thirty thousand dollars, to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States or Territories.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of agricultural experiment stations shall be annually paid in equal quarterly payments on the first day of January, April,

July, and October of each year by the Secretary of the Treasury, upon the warrant of the Secretary of Agriculture, out of the Treasury of the United States, to the treasurer or other officer duly appointed by the governing boards of said experiment stations to receive the same, and such officers shall be required to report to the Secretary of Agriculture on or before the first day of September of each year a detailed statement of the amount so received and of its disbursement, on schedules prescribed by the Secretary of Agriculture. The grants of money authorized by this act are made subject to legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State or Territory before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of any State or Territory for the further and more complete endowment, support, and maintenance of agricultural experiment stations as provided in this act shall by any action or contingency be diminished or lost or be misapplied, it shall be replaced by said State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys exceeding five per centum of each annual appropriation shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings, or to the purchase or rental of land. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the Secretary of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That on or before the first day of July in each year after the passage of this act the Secretary of Agriculture shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is complying with the provisions of this act and is entitled to receive its share of the annual appropriation for agricultural experiment stations under this act and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of Agriculture shall withhold a certificate from any State or Territory of its appropriation, the facts and reasons therefor shall be reported to the President and the amount involved shall be kept separate in the Treasury until the close of the next Congress in order that the State or Territory may, if it shall so desire, appeal to Congress from the determination of the Secretary of Agriculture. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury; and the Secretary of Agriculture is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of Agriculture shall make an annual report to Congress on the receipts and expenditures and work of the agricultural experiment stations in all of the States and Territories, and also whether the appropriation of any State or Territory has been withheld; and if so, the reason therefor.

SEC. 6. That Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, March 16, 1906.

Under the provisions of this act the several States and Territories each received $5,000 last year, making a total of $240,000. As the

act passed late in the year, only a short time remained in which to plan for the expenditure of this fund, and this period was materially lessened by events following the passage of the act, the history of which is necessary to an understanding of the use made of the funds in 1906.

HISTORY OF FIRST YEAR'S APPROPRIATION.

Immediately upon the signature of the bill by the President telegrams were sent to all the stations notifying them of this fact, and the following circular letter was then mailed:

MARCH 20, 1906.

DEAR SIR: You are doubtless informed of the passage of the Adams bill and its signature by the President, making it a law. The funds of this year will become available to the several States and Territories upon the assent of the legislature to the provisions of the act, or of the governor in case the legislature is not in session. This assent should be forwarded to the Secretary of the Treasury, and should designate the beneficiary of the fund and the rate of division in States where it is to be divided. The treasurer or officer of the board designated to receive the fund should qualify by furnishing the usual credentials. As payment of the fund is to be made upon the warrant of the Secretary of Agriculture, a copy of the assent sent to the Secretary of the Treasury should be forwarded to this Office in order that the initial steps may be taken.

I inclose a copy of a circular letter from the Secretary of Agriculture, relating to the Adams Act and its administration. [See beyond.] Copies of the act will be mailed as soon as printed, and the new financial schedules will follow a little later. These will necessitate a separate account being kept of the Adams fund, but the classification of expenditures will remain unchanged.

Very truly, yours,

E. W. ALLEN,
Acting Director.

Some weeks later it was learned that the Secretary of the Treasury had called upon the Comptroller for a decision as to whether the initial appropriation under the act became available in the fiscal year 1906, and that the Comptroller had indicated an adverse opinion. This fact was communicated to the stations in the following circular letter, which had the effect of suspending plans for using the fund:

APRIL 21, 1906.

TO THE DIRECTORS OF THE AGRICULTURAL EXPERIMENT STATIONS:

Doubt has arisen as to whether the stations will receive any portion of the Adams fund this fiscal year. The Comptroller has under consideration the question whether the act applies to the present fiscal year, and has indicated an adverse opinion. In view of the present uncertainty, stations are warned against incurring expense under this new fund until the matter has been settled.

Very truly, yours, A. C. TRUE, *Director.*

The opinion of the Comptroller upon the points raised by the Secretary of the Treasury is as follows:

April 7, 1906.

The honorable the Secretary of the Treasury.

Sir: In your communication of March 27, 1906, you request an expression of my views upon the questions which you therein present as follows:

I have to invite your attention to "An act to provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditure thereof," approved March 16, 1906, copy inclosed; and in connection therewith to "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," approved July 2, 1862 (12 Stat., p. 503); and to "An act to establish agricultural experiment stations in connection with colleges established in the several States under the provisions of an act approved July 2, 1862, and of the acts supplementary thereto," approved March 2, 1887 (24 Stat., p. 440).

Relative to the provisions of the act of March 16, 1906, the views of the Comptroller are requested as follows:

1. The annual appropriation for experiment stations having already been made for the fiscal year 1906 in the agricultural act of March 3, 1905 (33 Stat., p. 881), including appropriations for Alaska, Hawaii, and Porto Rico, does the first annual increase of $5,000 for each State and Territory become available for the fiscal year 1906, with yearly increase thereafter, as provided in the act, up to the maximum of $30,000; and does said act of March 16, 1906, provide for a specific annual appropriation from the Treasury for the full sums to be paid each State and Territory?

2. As Alaska, Hawaii, and Porto Rico appear not to have established colleges for agriculture and the mechanic arts in accordance with the act of July 2, 1862, yet have established experiment stations under appropriations made annually for several years in the agricultural appropriation acts, does the act of March 16, 1906, apply to those stations?

The bill reads:

That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, to be paid as hereinafter provided, to each State and Territory, for the more complete endowment and maintenance of agricultural experiment stations now established or which may hereafter be established in accordance with the act of Congress approved March second, eighteen hundred and eighty-seven, the sum of five thousand dollars in addition to the sum named in said act for the year ending June thirtieth, nineteen hundred and six, and an annual increase of the amount of such appropriation thereafter for five years by an additional sum of two thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be thirty thousand dollars, to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States and Territories.

Sec. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of agricultural experiment stations shall be annually paid in equal quarterly payments on the first day of January, April, July, and October of each year by the Secretary of the Treasury, upon the warrant of the Secretary of Agriculture, out of the Treasury of the United States, to the treasurer or other officer duly appointed by the governing boards of said experiment stations to receive the same, and such officers shall be required to report to the Secretary of Agriculture on or before the first day of September of each year a detailed statement of the amount so received and of its disbursement, on schedules prepared by the Secretary of Agriculture. The grants of money authorized by this act are made subject to legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State or Territory before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

This bill became a law on the 16th of March, 1906. While its language is somewhat obscure on the questions raised by you, yet reading the bill as a whole it appears to be reasonably certain that the first annual increase of $5,000 therein provided for the agricultural experiment stations for the States and Territories is not available for the present fiscal year 1906. It is found in an independent act, not in a regular annual appropriation bill. It is provided in section 3 of the act "that the sums hereby appropriated * * * shall be annually paid in equal quarterly payments on the first day of January, April, July, and October of each year * * *." It would be a physical impossibility to comply with this provision for the present fiscal year.

Section 4 thereof provides:

That on or before the first day of July in each year after the passage of this act the Secretary of Agriculture shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is complying with the provisions of this act and is entitled to receive its share of the annual appropriation for agricultural experiment stations under this act and the amount which thereupon each is entitled, respectively, to receive. * * *

It is apparent from this language that the first payment under the terms of the act should be made to those States and Territories complying with its terms on July 1 next. This will throw the payments for a year all within a given fiscal year, resulting in the payments being made at the beginning of a quarter instead of at its close.

The appropriating clause of the act, found in section 1, reads:

That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, to be paid as hereinafter provided, to each State and Territory, for the more complete endowment and maintenance of agricultural experiment stations now established or which may hereafter be established in accordance with the act of Congress approved March second, eighteen hundred and eighty-seven, the sum of five thousand dollars in addition to the sum named in said act for the year ending June thirtieth, nineteen hundred and six, and an annual increase of the amount of such appropriation thereafter for five years by an additional sum of two thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be thirty thousand dollars. * * *

The language "in addition to the sum named in said act for the year ending June thirtieth, nineteen hundred and six * * *" is evidently used as descriptive of the $15,000 carried for each agricultural experiment station in the appropriation act for the fiscal year 1906, and not intended to make the appropriation therein provided applicable to the present fiscal year.

If a comma had separated the words "act" and "for," supra, Congress would have evidenced its intent to make the appropriation of $5,000 carried for the first year to each station applicable to the fiscal year 1906. But the comma is not there. Punctuation may be supplied to make an act intelligible and operative, but should not be supplied by construction when its effect would be to confuse and make a bill wholly or partially inoperative. Such would be the case if the comma were supplied in the language supra. I therefore answer your first question in the negative.

There is nothing in the act to evidence the intent of Congress to appropriate more than the $5,000 to each experiment station annually for the period of five years and an annual increase thereof of $2,000 per year for five years. The agricultural experiment stations in Alaska, Hawaii, and Porto Rico were not established in accordance with the act of Congress of March 2, 1887, but by independent act; hence they do not fall within the class of experiment stations for which the appropriations in this bill were intended.

I therefore have to answer your last question in the negative also.

Respectfully,

R. J. Tracewell, *Comptroller.*

Upon receipt of this opinion at the Department of Agriculture an argument was presented to the Secretary of the Treasury as a basis for reconsideration of the Comptroller's ruling, and evidence was presented to indicate the intention of Congress in passing the act. To this the Comptroller replied as follows:

TREASURY DEPARTMENT,
OFFICE OF THE COMPTROLLER OF THE TREASURY,
Washington, April 28, 1906.

The Honorable SECRETARY OF THE TREASURY.

SIR: I am in receipt, by the hand of your private secretary, this day, of the communication of the Acting Secretary of Agriculture to you, dated the 17th instant, in which he requests that I be directed to reconsider my decision of the 7th instant, as regards my holding that the appropriation made in the act of March 16, 1906, entitled "An act to provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditures thereof," did not become operative until the beginning of the next fiscal year.

On the 23d instant the Secretary of Agriculture submitted the following request for a decision:

> By the terms of the act of Congress approved March 16, 1906, entitled "An act to provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditures thereof," is a specific annual appropriation made from the Treasury for the full amounts to be paid each State and Territory under the terms of the act?

In the consideration of the latter request I had occasion to review my decision of the 7th instant, being the one which I am now requested to reconsider. On such review I arrived at the same conclusion set forth in the decision of the 7th instant as to the availability of the appropriation in question for the present fiscal year. I inclose you a copy of said latter decision.

If the contention of the Secretary of Agriculture is correct as to the intent of Congress to make an appropriation of $5,000 for each agricultural experiment station for the present fiscal year 1906, that intent could easily have been evidenced by some appropriate and intelligible language, and then for future years provide, as the bill does provide, that the sums therein appropriated, which include the $5,000 appropriation, shall be paid quarterly, as therein provided.

I must in construing acts of Congress take the language used, and all the language of a bill, and not the individual intent of some person, or give undue importance to any particular word or phrase. Applying the ordinary and usual rules of interpretation to the act in question, I am still of opinion that my construction thereof in the decision of the 7th instant is correct.

Respectfully,

(Signed) R. J. TRACEWELL, *Comptroller.*

In view of these opinions of the Comptroller that the act did not carry an appropriation for the fiscal year 1906, the Secretary of Agriculture addressed the following letter to Senator Proctor, chairman of the Senate Committee on Agriculture, a duplicate of which was also sent to Hon. H. C. Adams, the author of the bill, together with an amendment which it was proposed to add to the agricultural appropriation bill, interpreting the act and making it applicable to the fiscal year 1906:

MAY 1, 1906.

DEAR SENATOR PROCTOR: I am sending you herewith copies of decisions of the Comptroller of the Treasury dated April 7, 1906, and April 28, 1906. You will

note that the Comptroller will not recede from his construction of the law that the act of Congress approved March 16, 1906, commonly known as "The Adams Act," appropriates no money for the fiscal year 1906, and that the item of $5,000 is not available until the fiscal year 1907, with an increase each year for five years until the year 1912, when the appropriation will be $15,000. It was the understanding of the Department, and this understanding was general among the experiment stations, that the bill as passed appropriated $5,000 for the fiscal year 1906, and a good many of the stations will be handicapped if this money is not made available.

In this connection I inclose a provision which, if added to the appropriation bill for the Department, will make the sum of $5,000 available for the fiscal year 1906.

Very truly, yours, (Signed) JAMES WILSON,
Secretary.

Hon. REDFIELD PROCTOR,
United States Senate, Washington, D. C.

[Inclosure.]

Provided, That the act of Congress approved March 16, 1906, entitled "An act to provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditure thereof," shall be construed to appropriate the sum of $5,000 for the fiscal year ending June 30, 1906, the sum of $7,000 for the fiscal year ending June 30, 1907, the sum of $9,000 for the fiscal year ending June 30, 1908, the sum of $11,000 for the fiscal year ending June 30, 1909, the sum of $13,000 for the fiscal year ending June 30, 1910, and the sum of $15,000 for the fiscal year ending June 30, 1911, to be paid as provided in the said act to each State and Territory for the more complete endowment and maintenance of agricultural experiment stations now established or which may hereafter be established in accordance with the act of Congress approved March 2, 1887.

Owing to the consideration of the provisions for meat inspection which were incorporated in the agricultural appropriation bill, that bill was not passed until the closing day of the fiscal year. As soon, however, as the conferees had agreed upon the bill—June 29—the stations were advised of the fact by telegraph. They actually had, therefore, less than two days in which to arrange for spending the first appropriation under the act, but in quite a large number of cases work had been begun soon after the act was passed and considerable expense incurred, and in other cases plans had been laid for the lines of work to be undertaken and orders made out for apparatus, scientific books, etc., which would be necessary to the conduct of these investigations.

A circular explaining the limitations of the fund, the period for which it was available, etc., was mailed on June 30. Following is a copy of the circular:

JUNE 30, 1906.

To the DIRECTORS OF THE AGRICULTURAL EXPERIMENT STATIONS:

Under an amendment carried by the agricultural appropriation act passed June 29, the benefits of the Adams Act are made to apply to the fiscal year

ending June 30, 1906. Each State and Territory will receive the full amount of the first year's appropriation—$5,000—and any unexpended balance will be deducted from succeeding payments.

Since the passage of the above act construing the Adams Act it has been possible to secure a more liberal interpretation as to the period to which the first year's appropriation can be applied. The Solicitor of the Department holds that the rider on the agricultural bill construes an act which went on the statute books March 16, 1906, and hence that the fund directed to be paid for the fiscal year 1906 " is available for payment of all proper expenses from March 16, 1906, to and including June 30, 1906."

In a considerable number of cases it appears that stations have incurred expenses in anticipation of receiving the Adams fund, or have already started investigations under the Adams Act. Where practicable, such expenses may be charged to this first appropriation under the act. Apparatus, material for permanent equipment, books, etc., ordered prior to July 1 will be construed as contracted for and may be paid for out of the Adams fund for 1906, but in all such cases evidence should accompany each voucher that the materials were contracted for before the close of the fiscal year. A copy of the order for the materials will be regarded as satisfactory evidence. Bills for goods so purchased should not be dated back, but should bear the date of delivery of the goods.

All Adams fund vouchers should be clearly indicated as such, either by a stamp or otherwise. Schedules for reporting expenditures from both the Hatch and the Adams funds will be sent out in a few days. In future it is planned to have the financial reports on both funds made upon a single schedule, but the uncertainty of this year prevented the printing of schedules in this form.

The Adams fund for the coming fiscal year (1907) will be $7,000. It is the intention of the Treasury officials to combine the first installment for that year with the quarterly installment of the Hatch fund.

Very truly yours,

E. W. Allen,
Acting Director.

Under the conditions and in the short time remaining, four of the stations found it impracticable to use any of the fund last year; eighteen others, as shown in the following table, reported unexpended balances, which under the law have been deducted from the appropriation for the following fiscal year.

Unexpended balances of Adams fund, fiscal year ended June 30, 1906.

Alabama	$2,980.11	Oklahoma	$5,000.00
California	73.16	Oregon	5,000.00
Delaware	2,949.66	Pennsylvania	4.59
Idaho	1,817.96	Rhode Island	2,535.80
Indiana	5,000.00	South Carolina	1,439.88
Maryland	236.11	South Dakota	5,000.00
Michigan	3,308.40	Texas	2,123.09
Montana	2,582.87	Utah	178.06
Nevada	227.06	Virginia	2.05
New York (Cornell)	117.15	Washington	3,919.89
Ohio	1,485.98	West Virginia	2,140.88

The classified summary of expenditures given on page 210 indicates the manner in which the first year's appropriation was expended. As the money became available so late in the fiscal year it was used to a very large extent in providing facilities for the investigations and researches to be inaugurated under the act. These facilities consisted to a very large extent of scientific apparatus, laboratory equipment, special implements and machinery; scientific books and periodicals, and in some cases of live stock purchased with special reference to the requirements of the new investigations. In this way a large amount of necessary equipment was obtained, which was frequently one of the first requirements in inaugurating the work.

In the examination of the expenditures of the stations under this fund, the character of the material purchased, and its relation to investigation as distinguished from the routine work of the stations, has been made a subject of special inquiry. No charges for miscellaneous supplies, live stock for general purposes, supplies and fixtures for the administrative offices of the station, and the like, have been permitted. Special care has been exercised to confine the expenditures allowed to those directly connected with investigation already in hand or planned for. From our examination of the accounts and the financial reports upon this fund it is, in general, clear that the money has been wisely and judiciously expended in a manner that will greatly facilitate the new investigations and relieve subsequent appropriations.

ADMINISTRATION OF THE ADAMS ACT.

The Adams Act places the general administration of the fund in the hands of the Secretary of Agriculture, and gives him duties connected with it which are not carried by the Hatch Act. The quarterly payments are to be made "upon the warrant of the Secretary of Agriculture," and the act directs that the treasurer, or other officer appointed by the governing boards of the stations, shall "report to the Secretary of Agriculture on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement, on schedules prescribed by the Secretary of Agriculture." It further provides that "the Secretary of Agriculture shall ascertain and certify to the Secretary of the Treasury as to each State and Territory, whether it is complying with the provisions of this act and entitled to receive its share of the annual appropriation." It states specifically that "the Secretary of Agriculture is hereby charged with the proper administration of this law," and provides that he "shall make an annual report to Congress on the receipts and expenditures and work of the agricultural experiment stations in all of the States and Territories, and also

whether the appropriation of any State or Territory has been withheld, and if so the reason therefor."

In accordance with the authority so conferred, a circular letter was issued by the Secretary of Agriculture to the experiment stations, outlining the policy of the Department with reference to this fund, calling attention to the character of expenditures to which the fund is restricted, and designating the Director of the Office of Experiment Stations as his representative in all matters relating to the business of the Department in connection with the administration of the law. The text of this letter is as follows:

March 20, 1906.

To the Directors of the Agricultural Experiment Stations:

Congress having passed the Adams bill, which provides for an increased annual appropriation for agricultural experiment stations, and the measure having been approved by the President, it becomes my duty to undertake the administration of this law.

In order to facilitate the prompt and effective organization of work under this act and to provide for a proper accounting for expenditures authorized by said act, I have prescribed a schedule for the report of such expenditures for the fiscal year ending June 30, 1906, and until further orders, in accordance with section 2 of said act. Copies of this schedule will be sent later.

The Director of the Office of Experiment Stations is hereby designated my representative in all matters relating to the business of this Department in connection with the administration of this law, and the Office of Experiment Stations will aid in promoting effective work under this act in the same general way as it has heretofore in relation to the Hatch Act.

Under the terms of the act it will be necessary that a separate account of the Adams fund shall be kept at each station, which should be open at all times to the inspection of the Director of the Office of Experiment Stations or his accredited representative.

In the interpretation of this act and the examination of the work and expenditures of the stations under it, I have instructed the Director of the Office of Experiment Stations to be guided by the following principles:

The Adams fund is "to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States." It is for the "more complete endowment and maintenance" of the experiment stations, presupposing the provision of a working plant and administrative officers. Accordingly, expenses for administration, care of buildings and grounds, insurance, office furniture and fittings, general maintenance of the station farm and animals, verification and demonstration experiments, compilations, farmers' institute work, traveling, except as is immediately connected with original researches in progress under this act, and other general expenses for the maintenance of the experiment stations, are not to be charged to this fund. The act makes no provision for printing or for the distribution of publications, which should be charged to other funds.

In order that there may be no doubt as to the disposal of the Adams fund, each station should outline a definite programme of experimental work to which it will devote this fund, and expenses for other work should not be charged to it. The work contemplated by this act will, as a rule, necessarily cover more than one year, and changes in the programme once adopted should

not be made until the problems under investigation have been solved, or their solution definitely shown to be impracticable. This will give ample opportunity for making plans for winding up any particular piece of work and beginning another with such deliberation as will provide for the suitable and economical expenditure of this fund without resort to doubtful expedients or expenditures. It is much to be desired that this fund shall be a strong incentive to the careful choice of problems to be investigated, thorough and exhaustive work in their solution, and the securing of permanent and far-reaching results on which can be safely based demonstration and verification experiments leading to the general improvement of farm practice in many particulars.

No change will be made in the attitude of this Department toward expenditures under the Hatch Act. The Hatch fund should be as carefully guarded as ever, and be devoted to substantial experimental work and the printing and dissemination of the results of such work.

The increased liberality of the Federal Government in providing for the endowment of research and experimentation in agriculture should be a further incentive to the States and local communities to supplement these funds for the extension of demonstration experiments, farmers' institutes, agricultural colleges, schools, and courses of instruction, and the general education of the rural communities along industrial lines, in order that the masses of our farmers may be so educated from early youth that they will appreciate the benefits of original research and experimentation as applied to agricultural problems, and be able to appropriate in the most effective manner for their own benefit and the general welfare of the nation whatever practical results are obtained from the work of the agricultural experiment stations.

Very truly, yours,

JAMES WILSON, *Secretary.*

As many questions arose regarding the kind of work provided for by the Adams Act and the character of expenditures appropriate under it, it was deemed wise for the Office to pass upon the investigations proposed to be undertaken with it before the work was entered upon and expense incurred. The object of this was to avoid misunderstanding of the interpretation placed upon the act by the Department, and to guard against expenditures which it might be impossible to approve at the close of the year. A circular was therefore issued, outlining the method of procedure in inaugurating work under this new fund, and calling for the presentation of a list of the projects, giving their aim, general character, and approximate expense. The following is a copy of the circular sent to all the stations:

Subject: Projects under the Adams fund.

APRIL 30, 1906.

To the DIRECTORS OF THE AGRICULTURAL EXPERIMENT STATIONS:

The circular letter of the Secretary of Agriculture issued March 20, relative to the Adams fund, suggested that "each station should outline a definite programme of experimental work to which it will devote this fund." The drawing up of such a programme should be the initial step in preparing for work under the new fund, and this should lead to a careful choice of problems, definite and

specific in character, and planned to involve thorough and exhaustive investigation. It is important that the scientific spirit of the new act should be appreciated. In planning for work under it, "original researches or experiments" should be contemplated rather than activities of a more general or miscellaneous character.

Since under the ruling of the Comptroller of the Treasury the benefits of the Adams Act will not be derived until the beginning of the new fiscal year, there will be more time for considering and maturing plans for work under it. These plans are the more important, as they will presumably be for work to be continued for some time and will continue the basis for the expenditures. The project will be the determining factor in the matter of charges which will be legitimate under the fund; hence it is important that these projects should be definite and specific and sharply differentiated from the general activities of the station. In this way it will be possible to outline a budget for the expenditures and to make an intelligible showing of the use to which the funds are being put.

Obviously only a few projects can be planned for at present, as they will usually be rather large, important undertakings, involving considerable expense, and it is essential that sufficient funds be allotted to each so that the investigations may be carried out in a thorough and effective manner. Our investigation work in the past has frequently suffered from lack of sufficient definiteness of plan and from shortage of funds at critical junctures. Under the new fund interference from the latter cause should be guarded against, and the mapping out of the plans for work under each project in considerable detail will be a material aid to the investigators themselves and to the administrative officers of the stations as well. Such plans should have a definite object, should not be too broad in their scope, and should contain a statement of the probable expenses, including salaries from the Adams fund. The latter should be based on the proportion of time of the several workers which the projects will call for. While no expenses for general administration can be allowed from this fund, administrative officers who are conducting investigations under it may receive a part of their salaries from that source, the same as any other station worker.

As an illustration of the manner in which these projects may be outlined, a memorandum is inclosed of one in our nutrition investigations, showing the method taken in this Office to fix the scope and character of the undertaking, the amount of work to be performed, and the estimated expense. Some such plan would appear to be not only feasible in experiment station work, but a practical necessity.

It is such a programme as this which the circular letter of the Secretary of Agriculture contemplates. It will furnish the basis for an examination of the work and expenditures under the Adams fund, as provided for in the act. In order to promote a clear understanding upon the kind of work which may be regarded as appropriate, and the expense involved, it is suggested that a copy of the programme of each station be sent to this Office for inspection as soon as it has been completed. Obviously it will not be our intention to determine what lines of work it will be most advisable to undertake with the fund in the several States, but only to reach such an agreement as to the character of work to be undertaken under this act as will facilitate the passing of intelligent judgment on the legitimacy of expenditures of the Adams fund.

Very truly, yours,

A. C. TRUE, *Director.*

PROJECT.

A study of the relation of various foods and diets to the amount of muscular work performed by men. This investigation to be made through metabolism experiments in the respiration calorimeter.

Estimated expense for the fiscal year ending June 30, 1906.

Salary of expert in charge	[a] $1,800
Salary of analyst	[a] 750
Salary of editorial assistant and tabulator	[a] 750
Salary of stenographer	[a] 300
Salary of temporary assistants	[a] 500
Construction of modifications in apparatus	500
Repairs to apparatus	100
Chemical and other supplies	300
Total	5,000

Not less than twenty experiments should be made during the year, with analyses of food and feces, and detailed calculation of results and preparation of report.

The wisdom of this plan has been fully evidenced by the correspondence which has followed the issuance of the circular. This correspondence has brought out a considerable diversity of opinion as to what constitutes original investigation in agriculture, and has enabled the Office to illustrate clearly its ideas in a wide range of cases. This action has, moreover, resulted in a widespread discussion of the subject of agricultural investigation among various classes of station men, which has led to a clarifying of views and a higher conception of the ultimate importance to agricultural practice of more systematic and fundamental research. The outlining of the projects in a clear and definite way, with a plan for their continuance until a definite answer has been secured, has also been beneficial to the station workers, and has served to systematize the plans of the stations themselves.

It is gratifying to report that there has been very general acceptance and approval of the high standard established by the Office for the work under this fund, and the plan of procedure adopted. The administration of this fund was the most important theme discussed by the Association of American Agricultural Colleges and Experiment Stations at its convention at Baton Rouge in November, 1906, and received much attention. There was a broad discussion of the subject of agricultural research, its relation to the other activities of the experiment station and to the general public. There was a general disposition to recognize the great opportunity presented by this act, wholly apart from the legal requirements which

[a] Only a portion of the time of these persons to be employed on respiration calorimeter work for the Department.

it carries, and to realize in full measure the provision it makes for adding to our fund of definite scientific knowledge in agriculture.

The general attitude of the association was well expressed in the report of the new standing committee on station organization and policy, which is composed of the following representative station directors: E. Davenport, of Illinois, chairman; C. D. Woods, of Maine; W. A. Henry, of Wisconsin; H. J. Waters, of Missouri; M. A. Scovell, of Kentucky, and C. E. Thorne, of Ohio. This report states that—

The committee found itself in accord with the Office of Experiment Stations in regard to the general scope of investigations that can properly be undertaken under the Adams Act. There has been during the year the most cordial relation and a very complete understanding between the committee and the Office of Experiment Stations in regard to the policy to be pursued, and the committee heartily indorsed the letters and circulars of the Office relative to the Adams Act.

While the committee deemed it impracticable at that time to determine in detail the kinds of work to be fostered under the new fund, it laid down the following broad proposition:

It is evidently the intention of the Adams Act to provide the means for carrying on investigations of a relatively high order with a view to the discovering of principles and the solution of the more difficult and fundamental problems of agriculture. To this end it is very desirable that careful attention shall be given to the choice of definite problems to be studied and the methods by which the solution of these problems is to be sought. Investigations in connection with which there is good reason to expect the establishment of principles of broad application should be preferred to those which have only local or temporary importance or from which only superficial results are to be obtained.

The ideal college should be symmetrical, in that it is equally developed in all lines. A station need not be symmetrical. One or two strong departments are better than many weak departments. In selecting the lines of work due reference should be given to the special needs of the State in which the station is located, but the lines of work adopted should be only such as have a reasonable expectation of leading to the establishment of principles of broad application. These lines of work need not be new lines. Indeed, strengthening lines of investigations now in progress may be fully as important as the establishment of new lines.

At the present time we must confine ourselves to general principles in selecting the line of research to be taken up under the Adams Act.

To be sure that these lines are in the scope of the Adams Act, it will be necessary for the station administration to clearly understand what constitutes research.

Only a few lines can be advantageously undertaken at a time. What these lines of investigation shall be must be determined chiefly by the equipment of the station in men and facilities.

The commanding position of the man as the most important factor in research was strongly emphasized by the committee, and almost as a corollary to this it was urged that "the man and his line of work must be suitable to each other."

KINDS OF WORK UNDER THE ADAMS ACT.

While very little investigation was actually conducted with the Adams fund during the fiscal year 1906, the provision for filing with this Office a list of projects to be undertaken with the fund makes it possible to give a general idea of the character of these undertakings.

In passing upon these projects the Office has undertaken to determine only their suitability and appropriateness under the terms of the act. It has left to the individual initiative of the station workers the planning of the investigations and the selection of the topics most important to their localities. The Office has insisted only that the projects as outlined should be such as to characterize them as scientific investigations, embracing some original features. It has not presumed to pass, except in an advisory way, upon the feasibility of the investigations, the method of procedure, or the probability of the work leading to conclusive results. While it has made many suggestions for the strengthening of the investigations, these suggestions have necessarily been advisory, rather than mandatory, since the responsibility for the planning and execution of the investigation must rest with the station worker. Every effort has been made to lead by suggestion, to inspire the spirit of investigation, and to preserve the individuality and the initiative of the investigator. The reasons for failure to approve certain projects submitted have been fully stated, and the general principles which have governed the Office in its examination of these projects and the standards it has established have been fully presented in publications and in correspondence.

The most evident difficulties in planning work under this fund have been (1) a lack of clear discrimination between investigation in a strict sense and the ordinary experimental work, (2) a lack of definiteness in the purpose and plan of the investigation, (3) a tendency to take up too large or broad problems, and (4) the outlining of too large a number of projects. The terms "research" and "investigation" have been used freely in reference to experiment station work, and often more broadly than they are employed in science generally. We have fallen into the habit of speaking of much of the work as investigation which in a strict sense can not be regarded as of that grade. The result has been considerable confusion in the minds of station workers, as well as the general public, as to the distinction between this and other grades of work less technical and fundamental in character. Research is worthy of the name only as it is directed to the answering of definite problems by scientific methods of procedure. This will involve a definite plan of operations and thorough consideration of what is known of the subject and its bearing, and should lead to a knowledge of the reasons for the results secured.

Again, research presupposes a definite aim and a definite problem to be solved, a specific end to be attained rather than the mere accumulation of data. In the matter of projects the Office has insisted that this definite aim should be apparent, and that the work should be directed toward some problem or phase of a problem which would result in a contribution to our knowledge, making it less empirical and more definite. It has declined to approve plans for conducting surveys, the making of collections of and for themselves, the making of compilations and of monographs, studies of broad questions rather than specific problems or phases, the making of analyses or experiments merely to add to the general fund of data, the accumulation of observations not correlated with a definite line of investigation, the mere attempt to secure agricultural products of a superior quality without a recognition of the scientific principles involved and an attempt to add to our knowledge of them, or the conduct of experiments which add merely to our empirical knowledge but do not aim to throw light upon the fundamental principles. In a word, the effort has been made to set up the same standards for investigation and research in agriculture that are generally recognized in older branches of science.

While it is not planned to publish the projects presented by the different stations, a review of the list as a whole, with some of its salient features, will indicate the character and high grade of the work proposed and the broad field which these investigations cover.

As was natural to expect from the present interest in the subject, a large number of projects were proposed in plant breeding. These include thorough studies upon heredity in plants, the variability in morphological characters in cultivated wheat, the extent of hybridizing in nature and the environmental conditions associated therewith, effects of external environmental factors upon hereditable morphological characters, and the correlation of visible morphological characters with the presence and distribution of such constituents as gliadin, glutenin, and starch in the grain. Corn breeding for the semiarid region is being taken up from the standpoint of the factors which constitute drought resistance as a basis for such breeding, and the development of immune disease-resistant strains of crops on the basis of studies upon what constitutes immunity in different cases and the principles underlying development of disease resistance. These physiological studies will take up anatomical and chemical phases of the subject, such questions as the functions of tannin in the economy of the plant, its presence in pathological tissues, effect on parasites, etc.

In general, the pathology and physiology of disease is to be studied in a more comprehensive way than heretofore, taking up such matters as the relation between the character of the soil and certain diseases,

notably the relation of marly soils and of lime to chlorosis of citrus fruits, the specific influence of the different factors which go to make up climate upon the health of plants and their susceptibility to disease, and the relation of nutrition to the latter. Naturally a quite large number of plant diseases are to be made the subject of systematic study. In some cases these are new or little-understood diseases, and in others the object is to clear up doubtful points as to the organisms inducing them, their life cycle, relationships, susceptibility to various influences, means of dissemination, etc., as a more intelligent basis for combating them. There is opportunity for much profitable work of this kind, for in the pressure for results which should indicate remedies to be applied, it has often been impossible to go as deeply into the nature and cause of the disease and the influences affecting it as is clearly desirable.

The same is true to a considerable extent in the case of economic insects and the use of sprays and other treatment. Now that the opportunity is offered, it is found desirable to go back to some of our most common insect pests and study more thoroughly certain points in their habits and life histories, environmental conditions which affect them, and similar matters, as bearing ultimately on methods of control. The entomological work proposed is, as a whole, of high order, indicating for the most part a clear conception of the features of research and an appreciation of its importance as applied to that branch of science. The list of projects is also relatively large and varied. Several investigations have to do with the toxicity of various insecticides, the manner in which they act, and similar points, as well as of their physiological effects on the trees and plants receiving the treatment.

In horticulture there are several physiological studies which are of special interest and importance, such as the causes and means of control of fruit-bud formation on the apple and peach; the pyhsiology and philosophy of pruning and of grafting, both of which as planned involve extensive systematic studies; the elimination of the color of peach twigs by breeding to make them less susceptible to early frost; the factors affecting the setting of fruit on the tomato, to determine the cause of failure to set in dry localities where the plants bloom freely, and other studies of the effect of environmental conditions.

The subject of dry farming, in which there is such active interest of late, naturally suggested a considerable number of projects. A number of special investigations have been undertaken, such as the absolute water requirements of plants, the periodicity of this requirement, the water-holding capacity of the soil and factors which affect it, the conservation of the soil moisture, the breeding of drought-resistant crops, and the like.

The large number of soil investigations is a noteworthy feature of the list of projects. Aside from studies of the fertilizer requirements of soils and of laboratory methods and the composition of certain crops as indicative of these requirements, the work includes the nature and extent of the influence exerted upon crops by the previous growth of other kinds of plants, the relation between soil conditions and the quality of crops, such as the staple of cotton, the effect of sodium salts applied to the soil upon the organic and inorganic constituents of plants, the rôle of phosphorus and of potassium in plant nutrition, and the rôle of lime in the soil.

There are also several projects dealing with humus, its nature and determination, relations to soil fertility, rate of formation under different conditions, behavior and conservation in the soil, and effect of various factors on the humus content. To these are added studies in soil bacteriology as related to humus formation and change, relation of microscopic life of the soil to fertility in general, nitrifying and other biological properties of the soil, determination of the number, character, and biochemic functions of bacteria within the zone of tillage, to ascertain the part these organisms play singly and collectively in the setting free of plant food, and the bacteriological conditions in irrigated and unirrigated soil in the arid region, with special reference to the formation of nitrates and to the decomposition of barnyard manure. The number and character of these investigations give much encouragement for a better understanding of the complex factors which go to make up soil fertility and adaptation.

Closely related to these studies are various chemical investigations on plants and their products, such as the nonsugars in sugar cane, their nature and amount and the conditions which affect their formation, with special reference to sugar manufacture; the gluten content of wheat, cause of its deterioration and methods of correcting, the milling qualities of wheat as related to this and other factors; and the factors affecting the lupulin, volatile oils, and other active principles of hops. An investigation of the various sugars and coloring matters in cacti is also in progress, and the rationale of the ripening of the date is to be taken up.

Animal nutrition does not claim a large number of investigations, but these are of quite a different type from the ordinary feeding and digestion experiments to which the work has in the past been quite largely confined. Digestion experiments have been undertaken with reference to some particular point, rather than the determination of digestion coefficients for themselves. Among these are the behavior of the constituents of the nitrogen-free extract in digestion and their relation to nutrition, the influence of certain feeding stuffs

in depressing the digestibility of rations, and the nature and cause of this effect, the process of digestion as influenced by certain factors, and the effect of treatment or preparation of the feed on the digestibility of its constituents. Among the fundamental studies in animal nutrition are the influence of age and individuality on metabolism in cattle, an extensive investigation upon the use which animals actually make of their food at different periods of growth, considered from a physiological standpoint, the rôle of phosphates in animal nutrition, the effects and importance of various other mineral constituents, and the specific effect of certain foods on the product, such as the hardness or solidity of pork and the character of the fat in butter.

There are several quite elaborate projects dealing with the less understood properties of milk and their relation to differences in its nutritive value and the manner in which it agrees with people; but aside from these the dairy work is quite largely on the bacteriological side. Investigations are proposed upon bacteria other than disease germs in milk which are detrimental to digestion, the leucocytes in milk under normal and abnormal conditions and their sanitary significance, the constituents of cheese and their changes under the influence of certain classes of bacteria, and bacteriological and chemical investigations upon the disposal of creamery sewage, which is found much more resistant than municipal sewage, necessitating modification of the septic-tank method.

In animal breeding, investigations are to be made in heredity and upon the effects of inbreeding, the latter being planned to be the most systematic attempt ever made to study the effects of inbreeding upon domestic animals. In other investigations the breeding of animals under normal and abnormal conditions is to be studied, the effect of certain feeds, like cotton-seed meal, upon prepotency, and the whole problem of artificial impregnation. It is encouraging to see the breeding of animals taken up in a way to contribute more exact and reliable knowledge. Several other investigations in that field are being planned.

Veterinary science presents quite a list of undertakings of a thorough character relating to specific diseases, the immunizing of animals, with a study of the causes of natural immunity, stable ventilation in relation to the requirements of health, the active principles of plants poisonous to stock, and several quite elaborate studies upon the life history of the cattle tick as related to Texas fever eradication.

Several less usual topics are: A study of the conditions in the incubation of eggs under the hen as regards gases and physical factors, and their reproduction in artificial incubation; the optimum conditions for artificial incubation in dry climates; conditions deter-

mining the egg-laying capacity of fowls and the fertility of eggs; the cause of decay in eggs; and an investigation into the factors influencing wool production, the scouring of wool, and related topics.

While this list is in no sense a complete one in scope or extent, it serves to show something of the variety of topics undertaken and indicates in a general way the character of the undertakings. It will be evident that the subjects have been selected in a discriminating manner and are being attacked in a way to give a scientific answer which will disclose the various factors which are operative and something of their relative importance. Considering the conditions under which the first year's work had to be planned, the difficulties of securing men, the lack of uniform standards, and the like, the programme must be regarded as a very satisfactory one.

REPORTS ON THE STATIONS.

The following reports on the work and expenditures of the individual stations are, like previous reports, based on three sources of information, viz, the reports of personal inspection of the work and expenditures of the stations, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, and the printed reports and bulletins of the stations. The personal inspection of the stations has been made by the Director, the assistant director (E. W. Allen), W. H. Beal, and Walter H. Evans, who during the year visited all of the stations and reported the results of their examination. Mr. H. L. Knight has assisted in the compilation of the statements regarding the individual stations under direct supervision of Dr. E. W. Allen, the assistant director.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute,
Auburn.

Department of the Alabama Polytechnic Institute.

J. F. Duggar, M. S., *Director.*

An experiment was made at the Alabama Station during the year in growing tomatoes under glass, with results which indicate that the commercial growing of vegetables in greenhouses may be a profitable industry in the State. Studies of poultry, of cultural questions relative to the oat crop, and of the shedding of the squares and bolls of cotton have been brought to a close. A feeding experiment with beef cattle was completed by the sale of the cattle in New Orleans. As this experiment was successful as a commercial enterprise, it is believed that it will prove of service to the animal industry of the State. The availability of fertilizers is being studied, particularly as to the

effects of "fillers"—i. e., materials put in to add to the weight of fertilizers, but not of themselves of fertilizing value. The influence of vegetable matter on the solubility of different phosphates is also being investigated. The cooperative field experiments with numerous farmers of the State to ascertain the fertilizing requirements of cotton on different soils have been continued, and the botanist has carried on corn-breeding experiments near Montgomery. A comparative study of the quality of different lards as affected by various feeds has been begun, and the cane-sirup investigations previously undertaken have received special attention.

As a result of the passage of the Adams Act a department of entomology has been established and additional assistants have been employed in chemistry and veterinary science. Purchases of equipment have been made for the departments of entomology, chemistry, and agriculture, including an improved outfit for the manufacture of sirup.

During the past fiscal year the following publications have been received: Bulletins 131, Cooperative fertilizer experiments with cotton in 1901, 1902, 1903, and 1904; 133, The manufacture of cane sirup; and 134, Corn culture; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	10,488.33
Farm products	696.44
Miscellaneous	1,927.21
Total	33,111.98

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

With the growth of the business of the Alabama Station and the increase of its funds there is need of a stronger and more unified organization in order that the plans of work and the expenditures of funds may be more directly under the supervision of the director and the station thus more clearly differentiated from the other departments of the college.

Canebrake Agricultural Experiment Station, *Uniontown.*

J. F. Duggar, M. S., *Director, Auburn;* J. M. Richeson, M. S., *Assistant Director, Uniontown.*

The Canebrake Station has continued to devote its attention largely to the breeding of cotton on the worn-out soils in the region. From three years' experiments the results of plowing under various legum-

inous and nonleguminous crops indicate that such soils need nitrogen rather than humus. The yields of corn were but slightly affected by different methods of preparing the soil and planting the crop, and subsoiling for cotton was not successful.

The Bureau of Plant Industry is carrying on a demonstration farm near by, at which swine raising and alfalfa are being combined as supplements to cotton growing in the rotation, the results being very successful. Owing to the soil peculiarities there are difficulties in drainage which it is hoped to study. Tests of the relative value of commercial fertilizers have been carried on and some attention has been given to seed improvement. The Office of Public Roads has recently built an improved road between the station and Uniontown. These enterprises have stimulated a desire among the people of the vicinity for better agricultural conditions, and more interest is being manifested in the station work.

Bulletin 23, Experiments with cotton and corn in 1905, was the only publication received.

The income of the station during the past fiscal year was as follows:

State appropriation	\$2,500.00
Farm products	900.00
Total	3,400.00

Tuskegee Agricultural Experiment Station, *Tuskegee Institute.*

Department of the Tuskegee Normal and Industrial Institute.

G. W. Carver, M. Agr., *Director.*

The Tuskegee Station has continued to devote its attention very largely to the problem of improving the tilth and productiveness of the worn-out and eroded soils of the region. The results indicate that by the selection of clean seed, thorough preparation of the soil, and proper rotation of crops the various diseases may be reduced to a minimum, and that cotton, wheat, rye, oats, and barley can be made paying crops on even the poorest soils. Variety tests have been carried on with cotton, corn, cowpeas, peanuts, and sweet potatoes, and some attention has been given to the feeding of poultry and to poultry diseases. During the summer an agricultural wagon was equipped by the station and under the supervision of one of the staff was used in extension work throughout the county.

The publications of this station received during the fiscal year were Bulletins 7, Cotton growing on sandy upland soils, and 8, Successful yields of small grain.

The income of the station during the past fiscal year was as follows:

State appropriation	\$1,500.00

The Tuskegee Station is doing useful work along practical lines suited to the needs of its constituents. Taken in connection with

the agricultural department of the institute it is exerting a considerable influence for good.

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Kenai, Copper Center,* **and** *Rampart.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

C. C. Georgeson, M. S., *Special Agent in Charge, Sitka.*

The policy of restricting the work at the Alaska stations to a few lines has been continued with good results, and in spite of unfavorable weather conditions in some sections considerable progress is reported. The special appropriation by Congress for the introduction of live stock was expended for 11 head of Galloway cattle and 2 horses. The cattle have been divided between the Kenai Station and Wood Island. Although they have received no feed except the natural pasturage since their arrival, they are reported as being in fine condition. In response to a petition to the Secretary of Agriculture from the settlers of the Tanana Valley an investigation of its agricultural possibilities was made by the special agent in charge, who reported that the valley is well adapted to agriculture, as the term is understood in Alaska. A tract of about 1,400 acres at the junction of two railroads, and near the prosperous towns of Fairbanks and Chena, was surveyed and later reserved by Executive proclamation as a future station site.

At Sitka the horticultural investigations have been further developed. The nursery stock made a growth during the season that was considered on the whole satisfactory. Of a large number of varieties introduced several have been selected as quite promising, and these will be extensively propagated and given as wide a trial as possible. Experiments have been continued in the domestication of native varieties of raspberries and strawberries, and breeding experiments are being carried on to develop forms especially adapted to Alaskan conditions. During the past season attention has been given especially to the testing of varieties of potatoes, cabbage, and cauliflower, and Bulletin 2, Vegetable Growing in Alaska, has been issued. The seed distribution to settlers of the Territory and to the natives has been continued in cooperation with the Bureau of Plant Industry. A method for the production of lime in small quantities from the native limestone has been devised by the special agent, which will make practical the liming of many of the acid soils which could not hitherto be treated because of the prohibitive cost of imported lime.

At Copper Center, J. W. Neal, who has been in charge of the work since its inception in 1902, has resigned. The year has again been

devoted mainly to grain growing. About 40 acres have now been cleared and subdivided into about 200 plats, most of which are devoted to cereals and grasses. As in previous years, although most of the cereals were killed by frost about the middle of August, a few varieties matured their crops, from which it is hoped to breed earlier and more hardy sorts. Fall plowing has been found essential for crop production in this district, as it reduces very materially the spring work and enables the crops to be sown earlier in the season.

At Rampart grain growing has also been the chief line of work. Although this station is $3\frac{1}{2}°$ farther north than that at Copper Center, winter wheat, winter rye, barley, and oats matured and all hardy vegetables were successfully grown.

Animal husbandry and dairying have been the main lines of work at the Kenai Station. About 25 acres are under cultivation, most of which are in grass or have been sown with oats for grain and hay. Besides the Galloway cattle recently added, there is a small native herd, making a total of 17 head of cattle, all in good condition. Butter and cheese are being regularly produced and find a ready market.

The income of the stations during the past fiscal year was as follows:

United States annual appropriation	$1,500.00
United States appropriation for live stock	3,000.00
Farm products	350.70
Total	18,350.70

The Alaska stations are doing invaluable pioneer work, but their usefulness could be much extended if additional funds were available. The equipping and development of the experimental tract in the Tanana Valley are urgently needed, since the results from the existing stations show clearly that remarkable variations of climate exist in different parts of the Territory and that the possibilities of the great valleys can only be ascertained by a separate investigation of each. The live-stock investigations should also be broadened to include other breeds of cattle and some hardy breeds of sheep.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, ***Tucson.***

Department of the University of Arizona.

R. H. FORBES, M. S., *Director.*

The Arizona Station is continuing its chemical studies on the effects of mining detritis and other sediments on irrigated lands, especially with regard to the toxic effects of copper on plant growth.

The evidence thus far indicates that copper is filtered out to such an extent that it does not injure the plants, but that the injurious effects often observed are due to the physical action of the detritis on the soils over which it spreads.

The botanist has published some observations on the life history and feeding value of alfilaria, a forage plant extensively introduced into the Territory about thirty-five years ago and widely disseminated through the agency of sheep. As the plant produces a large amount of nutritious spring forage and is well adapted to southwestern conditions, it is recommended for grazing areas. Grazing range investigations near Tucson have been continued, as have also studies of the economic value of cacti and of the viability of native grasses. Work in the forage garden at the station has resulted in the selection of several varieties for more extensive experimenting. The botanical work of the station is to be enlarged to include vegetable physiology and pathology under the direction of W. B. McCallum, Ph. D., of the University of Chicago.

Date-palm culture continues to be a prominent feature in cooperation with the Bureau of Plant Industry. A date orchard (Pl. I, fig. 1) of 7 acres has been established at Yuma on land donated for the purpose, and a special appropriation has provided funds for a small cottage. Progress is also being made at the Tempe orchard, where a dwelling for the foreman, pumping plant, barn, and other equipment have recently been provided. About 3,000 pounds of dates were harvested this year, which were marketed as fresh fruit. A distribution of suckers was made to growers so far as the supply permitted. The interest in this project is very great.

A beet-sugar factory, costing $800,000, and with a capacity of 800 tons of beets per day, is being erected near Phoenix, largely as a result of the work of the station in stimulating beet culture. As soon as the factory starts, feeding experiments with beet pulp will be begun.

Other investigations recently inaugurated include feeding and pasture experiments with sheep and pigs, the protection of small fruits and vegetables from excessive heat and cold by shading, horticultural and economic problems in olive growing, and the culture of miscellaneous crops in the Colorado River flood plain. The station now has an appropriation of $2,700 for farmers' institutes, and the animal husbandman is giving special attention to this work. The equipment of farm buildings (Pl. I, fig. 2) at Phoenix has been materially added to during the year.

The publications of this station received during the year comprise Bulletins 51, Timely hints for farmers, and 52, Alfilaria (*Erodium cicutarium*) as a forage plant in Arizona, and the Annual Report for 1905.

FIG. 1.—DATE ORCHARD OF THE ARIZONA STATION NEAR TEMPE NOW COMING INTO BEARING.

[Recently set plants in the foreground.]

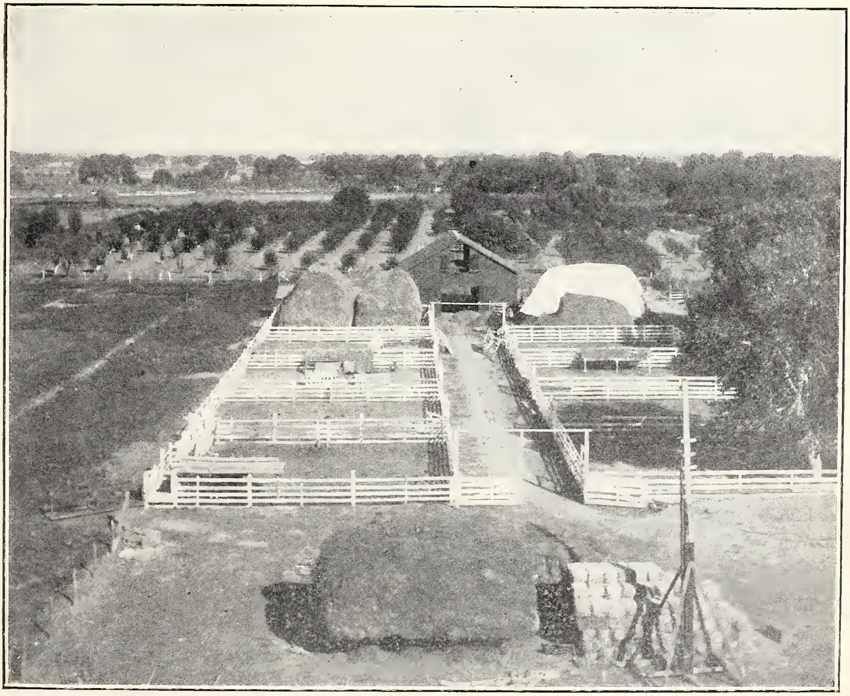

FIG. 2.—NEW BARN, STOCKYARDS, AND FEEDING PENS AT ARIZONA STATION FARM NEAR PHOENIX.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	10,396.16
Farm products	1,041.56
Miscellaneous, including balance from previous year	325.19
Total	31,762.91

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

Active and aggressive work characterizes the operations of the Arizona Station, and it is having a strong influence on the development of agriculture in the Southwest.

ARKANSAS.

Arkansas Agricultural Experiment Station, *Fayetteville.*

Department of the University of Arkansas.

W. G. Vincenheller, *Director.*

During the past year the Arkansas Station has completed investigations along several lines. The experiments in rice growing under irrigation, which have been carried on in Lonoke County in cooperation with this Office, are reported to have been an unprecedented success. About 5,000 acres have been planted with rice this year by the farmers of the county. The horticulturist has brought to a close his studies of the improvement of old orchards. His results show that the failure of orchards in Arkansas is due chiefly to soil exhaustion. By the use of fertilizers and cover crops, and by pruning and spraying properly conducted, a production of 90 per cent of first-class fruit may be expected even from orchards 15 years old. The chemist reports that analyses of foods on the market indicate that 47 per cent of such articles are adulterated. The veterinarian has completed some preliminary investigations with anthrax, together with a study of the value of vaccination with the commercial vaccines as a preventive, and the efficacy of field sanitary work in its control. Additional investigations as to the toxic effects of cotton-seed meal for swine and poultry indicate that adult poultry may be fed cotton-seed meal in large proportions without detriment, but that this can not safely be done with hogs.

Investigations now under way include tests of various grain and forage crops, corn breeding, crop rotation, dietary studies of private families and student organizations in the vicinity, a chemical method for destroying stumps, and studies of the digestibility of the forage crops of the State, and of the origin and chemical composition of the

so-called "prairie dog" mounds. An entomological survey of the State has been begun. Tick eradication work is being carried on, and there is some variety testing of apples.

As a result of the additional funds provided by the Adams Act, new departments have been organized in animal husbandry, dairying, and entomology, and additional assistance has been provided for research work in horticulture and animal diseases. All divisions of the station have received additional and improved equipment and new investigations have been initiated.

During the year the following publications of this station have been received: Bulletin 87, Glanders of horses; 88, Food adulteration in Arkansas; 89, Rice growing in Arkansas; 90, The cattle tick in Washington and Benton counties; and 91, Suggestions upon the care of apple orchards; and the Annual Report for 1905, which includes a financial statement for the fiscal year ending June 30, 1905, a list of fertilizers registered for sale in Arkansas in 1905, and a reprint of Bulletins 83-87.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	[a] 34,984.92
Farm products	1,472.95
Total	56,457.87

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

New buildings have been erected for the agricultural and dairy departments (Pl. II) of the university, portions of which will be occupied by experiment station officers, thereby providing largely increased accommodations. These, together with the additional equipment, will materially strengthen the station work as a whole. Liberal appropriations were made to the station by the State, and the outlook is very promising.

CALIFORNIA.

Agricultural Experiment Station of the University of California, *Berkeley.*

Department of the University of California.

E. J. Wickson, A. M., *Acting Director.*

The policy of the California Station has proceeded toward a fuller distribution of responsibility and clearer specialization among members of the staff, with manifest improvement in spirit and confidence.

[a] For two years.

FIG. 1.—NEW AGRICULTURAL BUILDING, ARKANSAS STATION.

FIG. 2.—NEW DAIRY BUILDING, ARKANSAS STATION.

Opportunities for extension of work have been provided by special State appropriations for the purchase and equipment of a farm; for a laboratory for the study of plant diseases in southern California; for investigations of pear blight, walnut blight, and viticulture; for improvement of cereals, and for studies of poultry problems and diseases. A farm of 780 acres has been secured near Davisville in the Sacramento Valley about 85 miles from Berkeley, and is being put in condition for instruction and investigation work. Under the State appropriation for a study of plant diseases, plans are being made for a pathological laboratory at Whittier and for a cultural station at Riverside which will be chiefly devoted to work with citrus fruits. The farm at Davisville will incidentally be utilized to extend the scope of the cereal investigations which are now being conducted at Yuba City and Modesto. Some work is also being carried on at the substation at Tulare, and the forestry substation at Santa Monica is being restored under the State appropriation for that purpose.

The most notable development of the work has been in plant diseases, entomology, and agricultural technology. Although handicapped by inadequate equipment, the entomologist has made marked progress in investigations on mosquitoes, the codling moth, corn worm, cherry worm, woolly aphis, oak caterpillars, tussock moth, a new pear thrips, food of orchard birds, and spraying problems, besides expanding the courses of instruction in the university and establishing a correspondence course. The work in agricultural technology has been mainly devoted to studies concerning the effect of environment on the composition of sugar beets, the canning of cured prunes, and the improvement of cereals in yield, composition, earliness, resistance to drought and disease, and milling, baking, and bleaching quality by means of cross breeding, selection, and improved methods of culture. Improved special laboratory facilities for this work have been added, and the cultural work will soon be amply provided for.

A small zymological laboratory for special studies relating to vinification has also been equipped, and an efficient method of controlling the product and preventing losses from spoiled wine has been worked out. The viticultural work has also included studies of adaptation, diseases (particularly Anaheim disease and mildew) and disease resistance, grafting, pruning, fertilizers, etc.

An important line of work has been poultry investigations, including digestion experiments with hens, and studies of roup and chicken pox. A study of the San Francisco milk supply has been made in cooperation with the city authorities, and considerable data have been collected regarding the control of bovine tuberculosis. Soil studies have continued as formerly, including analyses of soil samples from various sources, studies of soil moisture, green manures, and

summer fallowing in their mutual relations, growth of legumes with inoculation and irrigation, and movement and loss of water in furrow irrigation and with soil mulches. Some attention has also been given to a study of the efficiency of various canal linings, drainage problems, and seepage losses. The nutrition investigations in cooperation with this Office have comprised largely studies of the digestibility of fruit and nuts.

The university has recently been the beneficiary of a bequest by the late Theodore Kearney, of Fresno, of property valued at about $1,000,000. If the property is finally awarded to the university by the probate court, it is expected that the income of about $50,000 per year will be used for agricultural instruction and research in the San Joaquin Valley.

The station is now well provided with funds for printing the results of its investigations and the volume of its publications has materially increased. During the past year bulletins were received as follows: 166, Spraying for scale insects; 167, Manufacture of dry wines in hot countries; 168, Observations on some vine diseases in Somona County; 169, Field observations upon the tolerance of the sugar beet for alkali; 170, Studies in grasshopper control; 171 and 173, Commercial fertilizers; 172, Tomato diseases in California; 176, Sugar beets in the San Joaquin Valley; and 177, A new method of making dry red wine. The station has also issued a number of circulars on the culture of the sugar beet, codling-moth control, recent problems in agriculture, agricultural education, seed wheat, caterpillars on oaks, and teaching agriculture in the public schools.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United Sates appropriation, Adams Act	5,000.00
State appropriations for special invesigations, including substations	27,277.04
Farm products	1,440.77
Individuals	232.42
Miscellaneous, including balance from previous years [a]	18,118.81
Total	67,069.04

Reports of the receipts and the expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The State has shown a disposition to be liberal in appropriations for agricultural investigations, but generally for specific pieces of work. There is still need for appropriations which can be used for

[a] Including $10,000, estimated portion of salaries paid from the general funds of the university to members of station staff who are employed in both instruction and research.

general purposes. One of the great needs of this station, viz, improved facilities for field work under more perfect control of the central station has, however, in large measure been met.

COLORADO.

Agricultural Experiment Station, *Fort Collins.*

Department of the State Agricultural College of Colorado.

L. G. CARPENTER, M. S., *Director.*

The principal lines of work of the Colorado Station have remained substantially the same as in previous years. The most notable recent development has been of what are termed "western-slope fruit investigations" at Grand Junction. These include a variety of studies on diseases, insects, and cultural methods, as well as seepage and drainage investigations. This work is done in cooperation with local fruit growers and fruit growers' associations, who have contributed about $1,500 besides the use of lands and orchards. A field entomologist has been employed for this work and the assistant horticulturist has been transferred to it.

Steady progress has been made in the horse-breeding investigations in cooperation with the Bureau of Animal Industry, in determining the value of the American trotter as foundation stock for an American carriage breed. Thirteen of the 19 mares now have fine colts by Carmon, the head of the stud, some of which give excellent promise as material for the continuation of the investigations. Additional mountain pasture land has been secured for the breeding stock, making about 900 acres now available, and a horse-breeding stable has been erected at a cost of about $5,500. In other lines of animal industry experiments have been carried on in the wintering of steers, feeding experiments with pigs and sheep, and studies of the cause and nature of loco poisoning.

In entomology especial attention has been given to the pine and spruce lice, the potato flea-beetle, the codling moth, and local insects. The chemist is continuing studies on the deterioration of manure under Colorado conditions, the digestibility and available energy of Colorado hays, and on alkali.

The tract of 73 acres of land recently secured near the station for experimental purposes has been systematically laid out for work in agronomy, including variety, breeding, fertilizer, irrigation, and culture tests of cereals, sugar beets, potatoes, alfalfa and other forage plants. The effect of alkali and other conditions on the brewing quality of barley is being studied, and attempts are being made to breed a winter durum wheat and better seed-producing and disease-resisting alfalfa. Cooperative experiments with farmers in the improvement of potatoes, with a view to producing local-grown seed

potatoes, and the growing of durum wheat, oats, and vetch at different altitudes have considerably increased. The Arkansas Valley substation has been utilized chiefly for experiments on the improvement of cantaloupes and alfalfa.

During the past fiscal year 11 bulletins and 2 annual reports were received from the station, as follows: Bulletins 102, The value of sugar-beet pulp, alfalfa hay, and ground corn in fattening steers; 103, The thorough tillage system for the plains of Colorado; 104, A rust resisting cantaloupe; 105, A new apple rot; 106, Pruning fruit trees; 107, Peach mildew; 108, Development of the Rockyford cantaloupe industry; 109, Cultural methods for sugar beets; 110 and 111, Alfalfa; and 112, A hopperdozer; and the Annual Reports for 1901 and 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	[a] 14,000.00
Miscellaneous, including balance from previous year	3,274.28
Total	37,274.28

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Colorado Station has many useful lines of work in progress and under consideration. Closer organization and clearer differentiation of college and station work and funds would be of great benefit, as would also be an increase of supplementary lump sum appropriations by the State for experimental purposes under fewer restrictions than are the Federal funds. Such appropriations will be especially necessary in order to secure the most efficient use of the funds made available under the Adams Act.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

E. H. Jenkins, Ph. D., *Director.*

The corn-breeding experiments of the Connecticut State Station have been a new feature of its work during the past year. The principle of selection has been an increased sugar content, and a study of the effect of climate on this has been begun. Additional land has been leased near the station for the purpose, and six farmers in different parts of the State are cooperating under the direction of the agronomist.

[a] Two years.

The investigation in tobacco improvement by methods of seed selection and hybridization has resulted in the establishment of two hybrid varieties of decided promise. Several years' tests in plats of an acre or more indicate that both the broad leaf and Connecticut Habana seedlings are superior in shape, size, and vein of leaf to those from which they originated, while in other respects the quality is in no way impaired.

The station forester has given attention to a study of the growth of chestnut trees and to the establishment of small plats of woodland for the future study of forest problems. The entomologist and botanist have carried on cooperative work and demonstration experiments with a number of farmers. There has also been some extension work, chiefly through farmers' institutes and other farmers' organizations.

A substantial brick laboratory building, costing $15,000, has been completed, the cost being met in part from fees accumulated from the inspection work. An exceptionally well-equipped laboratory has been fitted up on the first floor for the researches on proteids, carried on under a grant from the Carnegie Institution. The second floor is to be used for the work in plant breeding and forestry.

The Adams fund available for 1906 for Connecticut was divided by the governor equally between the State and Storrs stations. A permanent division will be effected by the legislature at its next session. The inspection work required of this station by the State is increasingly heavy.

During the year the following publications of this station were received: Bulletins 152, The improvement of corn in Connecticut; and 153, The gypsy moth and the brown-tail moth; and the Annual Report for 1905. Parts 1–3 of this report are devoted to the results of the inspection of fertilizers, food products, and commercial feeding stuffs; part 4, to the report of the entomologist, including notes on scale insects, mosquito investigations, and insects visiting fruit blossoms; part 5, to the report of the botanist, giving notes on fungus diseases; and part 6 to tobacco-breeding experiments in Connecticut.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$7,500.00
United States appropriation, Adams Act	2,500.00
State appropriation, including balance of $450	15,950.00
Individuals	7,949.30
Fees, including balance from previous year	20,491.92
Miscellaneous, including farm products	443.70
Total	54,834.92

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Connecticut State Station is better equipped than ever before for thorough investigations in the lines in which it has undertaken work, and is thus in a position to make its work of greater usefulness to the agriculture of the State.

Storrs Agricultural Experiment Station, *Storrs.*[a]

Department of the Connecticut Agricultural College.

L. A. CLINTON, M. S., *Director.*

The policy of the Connecticut Storrs Station to concentrate its work along a few lines has been continued. Particular attention has been given to the poultry investigations. A wooden brooder outfit, holding 300 chickens, has recently been built at a cost of about $75. This will be compared with a more substantial house built at a cost of over $300. A poultry house is also being built for work in breeding. In experiments thus far a wooden house holding about 25 hens and costing about $25 has proved best. The investigations with pigeons and the production of squabs have been brought to a close.

The station has inclosed about 30 acres of land with woven-wire fence and connected the pasture with the college water system. This equipment is being utilized for experiments in sheep raising. A flock of 25 pure-bred Shropshires has been purchased by the station, and the adaptability of sheep breeding and feeding to New England will be studied.

The soft-cheese investigations in cooperation with the Bureau of Animal Industry have been continued. The manufacture of Camembert cheese has been put upon a working basis, and problems in the making of Roquefort cheese are now being taken up. The State appropriation for work on the nutrition of man has been used for this purpose, and the investigations at Middletown in cooperation with this Office have been discontinued.

Some extension work is being done by the station, chiefly through the farmers' institutes and other farmers' organizations. A number of changes in the personnel have recently taken place, notably the resignations of the dairyman, chemist, and bacteriologist. W. M. Esten has been placed in charge of the work in bacteriology and C. D. Jarvis in horticulture.

Pending final action by the legislature at its next session the governor divided the Adams fund available for 1906 equally between the Storrs and State stations.

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[a] Telegraph address, *Storrs* via *Willimantic;* railroad station, express, and freight address, *Eagleville.*

During the year Storrs Hall, the new college dormitory, has been completed at a cost of $60,000. A legacy of the late Edwin Gilbert bequeathed to the college a farm at Georgetown of about 356 acres, together with all tools, machinery, agricultural implements, live stock, and buildings, upon condition "that the same be taken and maintained in connection with said college as a farm and for the purpose of teaching or instruction in farming practically." In addition $60,000 was left to the college, the interest of which is to be used for caring for the farm and for instruction in agriculture, especially animal husbandry.

Bulletins 36, Poultry suggestions for the amateur; 37, The so-called "germicidal property" of milk; 38, The marketing of poultry products; 39, Pig-feeding experiments; 40, Creamery problems; and 41, Spraying notes, 1904–5, were received during the year from this station.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$7,500.00
United States appropriation, Adams Act	2,500.00
State appropriation	1,800.00
Miscellaneous	581.33
Total	12,381.33

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Connecticut Storrs Station has materially improved its equipment and has made its work more thorough. It is also broadening its relations with the farmers of the State and securing their confidence and support in increased measure.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark.*

Department of Delaware College.

H. Hayward, M. S. Agr., *Director.*

The unsettled conditions surrounding the Delaware Station culminated toward the close of the fiscal year in the retirement of the director, who was retained in charge of agronomy and animal husbandry. A new director, H. Hayward, has since been appointed.

The bacteriologist has been engaged in a study of nitroculture organisms, as to their condition in commercial cultures. These cultures were found unreliable for general farm use because of the inability of the organisms to withstand drying for any considerable time and retain their vitality. Field tests of fresh cultures of

Pseudomonas radicicola prepared in the laboratory, however, gave very gratifying results, especially when used in conjunction with lime, and are believed to be of value. The varieties of *P. radicicola* found on different species of legumes could not be differentiated by bacteriological methods and are considered to be identical.

A study of the mushroom industry has also been begun, particularly as regards buildings and market conditions from the standpoint of the amateur grower. American spawn cultures have been tested, and experiments are under way looking toward the control of the mushroom maggot.

Experiments with dust and liquid sprays for apples have been completed with satisfactory results. For Keiffer pears dust sprays have been a failure, while liquid sprays have been a complete success. Other horticultural work has included pollination experiments with apples, dipping nursery stock for the San José scale, further tests of various petroleum emulsions and insecticides, and cooperative experiments in apple breeding, pruning, and other orchard problems. There has also been cooperative work in spraying cantaloupes with Bordeaux mixture for macrosporium blight.

The chemist has been studying leguminous crops with reference to the amounts of manurial constituents removed from different soils with and without fertilizers, is carrying on cooperative experiments with crimson clover, and has continued work on petroleum emulsions.

The entomologist is studying, among other things, methods of control for the apple leaf miner and the plum curculio.

The publications of this station received during the past fiscal year were Bulletins 71, The action of formaldehyde in the preservation of milk; 72, Dust and liquid spraying; 73, The K–L emulsions and spraying; and 74, Some experiences with insecticides for the San José scale.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	286.00
Miscellaneous	32.00
Total	20,318.00

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The passage of the Adams Act made possible the purchase of some much-needed equipment for investigations in chemistry and soil bacteriology, but the needs of the station continue to be very urgent. Land for experimental work is especially necessary, as no funds are

available for even the rental of the necessary areas. A bill providing funds for the purchase of a farm to be used jointly by the college and station has been passed by the State legislature.

The new director has entered upon an aggressive and energetic campaign for strengthening the station work in a number of directions. If he receives the support of the governing board and the farmers of the State, it is believed that much will be accomplished, but without this the station can not expect to advance in effectiveness.

FLORIDA.

Agricultural Experiment Station of Florida, *Gainesville.*

Department of the University of the State of Florida.

P. H. Rolfs, M. S., *Director.*

The removal of the Florida University and Station from Lake City to Gainesville has been the leading event of the year. In consequence of it no new projects have been attempted by the station, but a number of lines of work have been brought to a close, including an extensive study of pineapple culture and marketing, and an investigation by the veterinarian of "salt sickness," or bovine uncinariasis. Considerable progress has also been made in the publication of accumulated material, the publications of the year including Bulletins 79, Insects of the pecan; 81, Fertilizer suggestions; 82, A preliminary report on growing Irish potatoes; 83, Pineapple culture, III—Fertilizer experiments; 84, Pineapple culture, IV—Handling the crop; and 85, Second report on pecan culture; and the Annual Reports for 1903, 1904, and 1905.

Cooperative tests with alfalfa and Irish potatoes and of the fertilizer requirements of cotton and citrus fruits have been continued with the farmers of the State, as have also tests of the adaptability of different varieties of potatoes and cotton and the introduction and acclimatization of a number of subtropical plants.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Farm products	853.04
Total	20,853.04

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

At Gainesville the station has been provided with laboratory facilities, farm outbuildings, a greenhouse, and a dwelling house. An experimental tract of about 40 acres has been reserved adjacent to

the station headquarters, besides additional fields for growing forage for the station live stock. About 15 acres are to be devoted to horticultural plantations. The facilities in most respects are better adapted to the requirements of the station than were those given up at Lake City, and the soil is much superior. On the whole the outlook for the Florida Station in its new location is encouraging. A period of adjustment to its new environment is inevitable, but the ultimate effect should be the rapid development and strengthening of its work.

GEORGIA.

Georgia Experiment Station, *Experiment*.[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

M. V. CALVIN, *Director*.

The Georgia Station has continued its extensive field experiments on fertilizers, cultures, etc., of feed crops, which have been carried on systematically for several years. A three years' study of the life history of the peach borer has been completed, which is believed to be the most important work from a practical standpoint that the horticultural department has as yet effected. Experiments looking to the discovery of means of control of the borer will be continued. A special study of varieties of figs is being made in cooperation with farmers in southern Georgia and Alabama and northern Florida. The station has obtained from California, France, and elsewhere over 100 varieties, and has arranged for the importation of other varieties from Italy. The introduction of the Smyrna fig in the southern part of the State is hoped for. The nomenclature and synonymy of the domestic fig and the process of caprification are to receive attention. Other horticultural investigations recently undertaken include cultivation tests with peaches, variety tests of seed corn, and field experimentation with soil inoculation for crown gall and the wilt of Japanese plums.

Feeding experiments have been undertaken to ascertain the relative value of cotton-seed hulls for wintering steers, the amount of cotton-seed meal which can safely be fed to pigs, and the relative value for dairy cows of silage versus hay, and soiling crops versus pasturage.

As a result of the passage of the Adams Act departments have been organized in plant breeding and plant pathology and in bacteriology. Additional assistants have been engaged in biology and horticulture and in dairy and animal industry, and the scope of the work has been increased. Considerable equipment has been purchased for these departments and additional buildings are to be erected.

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[a] Telegraph, freight, and express address, *Griffin*.

The demand for the station publications has increased during the past year. Cooperation of the horticulturist and animal husbandman with the State associations of fruit growers and live-stock breeders has helped to bring the farmers of the State into closer relations with the station, with mutual benefits.

The publications of this station received during the year were as follows: Bulletins 68, Japan and hybrid plums; 69, Corn culture; 70, Cotton culture; and 71, Some field notes on soil inoculation; and the Annual Report of the station for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	851.42
Farm products	2,711.11
Balance from previous year	2,566.41
Total	26,128.94

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

Since the close of the fiscal year a new director has been elected to succeed R. J. Redding, who has been in charge of the station almost from its establishment.

The agricultural people of Georgia have evidently become awakened to the importance of the wide diffusion of agricultural education as the basis for improved agricultural practice in that State. This is evidenced by the recent passing of a State law providing for the establishment of eleven agricultural high schools and the remarkable liberality of the local communities in providing means for the equipment of these schools, and also by a movement to strengthen and develop the State Agricultural College.

Since sound agricultural education is based on the facts and principles established by the careful and thorough experiments and researches which it is the business of the agricultural experiment stations to conduct, it is now more important than ever before that the station in Georgia, as well as elsewhere, should be directed and manned by men competent to supervise and conduct investigations which will steadily add to that knowledge of agricultural problems which the agricultural colleges and schools require to make their courses of instruction thorough and efficient.

HAWAII.

Hawaii Agricultural Experiment Station, *Honolulu*.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

Jared G. Smith, B. S., M. A., *Special Agent in Charge*.

The work of the Hawaii Station has been continued along the general lines of previous years, with especial attention to the introduction of promising industries. An experimental planting of several hundred varieties of grapes has been made at Makawao, on the island of Maui. In view of the continually increasing Portuguese population it is believed that grape growing and wine making may become profitable home industries.

The experimental work with tobacco which has been in progress for three years at Hamakua was attended with such marked success that arrangements have been made for growing the crop on a commercial scale. Drying and curing sheds have been erected and attempts will be made to prepare the crop for market. Considerable quantities of leaf tobacco were produced, cured, and manufactured during the year under the direction of the special agent in charge. A crop of Sumatra tobacco gave fully 20 per cent of leaves of excellent texture, valued by an expert tobacconist as worth from $2 to $4.50 per pound for cigar wrappers, and the remainder of the crop was nearly all adapted to use as filler. The tobaccos of the Cuban type were also of excellent quality, and when the yield per acre and the proportion of high-grade tobacco are considered, the possibilities of profit in this new industry seem manifest.

The greatly increased demand for rubber and the consequent increase in price have led the station to experiment with various kinds of rubber-producing plants with a view to ascertaining their relative worth under Hawaiian conditions. A considerable planting has been made on the slopes of the upper part of the station grounds, and the special agent has supervision of an experiment on the island of Maui in the cultivation of rubber and the fertilizer requirements of the trees.

The special agent has also devoted much of his time to coffee problems and is assisting in experiments relating to cultivation, topping, shading, curing, and marketing, as well as to diseases and insect pests. Efforts are being made to create a special market for the Hawaiian coffees based on the superior quality of the product.

With a view to rehabilitating the rice industry of the island, investigations pertaining to rice cultivation have been begun in the hope of offsetting the drawbacks of primitive Chinese methods and high land rent by the use of improved machinery, fertilizers, the

breeding and introduction of new varieties, irrigation, etc. Through the cooperation of the Bureau of Plant Industry, about 150 varieties were obtained for testing, among them several of superior merit. F. G. Krauss, for several years agriculturist at the Kamehameha schools, has been appointed to carry on this work. The use of land for the experiments has been donated and other assistance provided by various citizens.

The entomologist is continuing investigations along economic lines, including studies of the mango weevil and experiments for its control. Investigations are also being pursued on forest insects, those attacking coffee, citrus fruits, etc., and data are being collected for a report on the principal insect pests of the island. The experiments begun last year with bees and silkworms have been continued with satisfactory results, and it is believed that these home industries can be made profitable. The entomologist continues to act in connection with the committee having charge of the campaign for the elimination of mosquitoes, and largely through his efforts an experiment with top minnows from Texas has been undertaken. These minnows feed quite extensively on mosquito larvæ, and by their introduction it has been found possible to treat extensive breeding places that could not otherwise be reached.

The chemist has made a study of the composition of some Hawaiian-grown fodders and feed stuffs, which, while not complete, shows a decided deficiency in the lime content. He has also investigated the utilization of the waste products connected with the canning and shipping of fruits and of sugar making. In research lines he has pursued his studies on the nitrogen content of Hawaiian soils, paying especial attention to the pyridin compounds, which he has shown to be present in considerable quantities. Recently studies of the manganese content have been begun. In some parts of the island this element occurs in large quantities, and it is desired to learn its effect on plant growth. He has also studied the nature of fats and carbohydrates in some Hawaiian plant products, and poisonous principles in a number of plants of economic importance, such as sorghum, cassava, and arrow root, and in cooperation with the entomologist he is carrying on a study of Hawaiian honeys.

The collection of local varieties of bananas, avocados, mangoes, citrus fruits, and other economic plants is being continued by the horticulturist. Especial attention has been given to the marketing of tropical fruits and to tests of various methods of handling, packing, and storage. A large experimental shipment of pineapples, bananas, avocados, papayas, etc., was accompanied to San Francisco, Portland, and Seattle in order to study the conditions. This investigation is considered of great importance, as little attention has been given to

the marketing of such products, and with the possible extension of horticulture in the islands an outlet for the surplus must be provided.

During the year the station has issued Bulletins 9, Citrus fruits in Hawaii; 10, Insect enemies of tobacco in Hawaii; 11, The black wattle (*Acacia decurrens*) in Hawaii; 12, The mango in Hawaii; and 13, The composition of some Hawaiian feeding stuffs.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Insular appropriation	3,204.55
Individuals	124.50
Fees	30.00
Farm products	522.10
Total	18,881.15

The Hawaii Station is making considerable progress in aiding in the diversification of the agriculture of the islands. Its investigations have shown the possibilities of new industries and in a number of instances individuals have undertaken new enterprises. The increasing demands made upon the station for its publications and for scientific assistance show that it is being recognized as an important factor in the development of the country.

Hawaiian Sugar Planters' Experiment Station, *Honolulu.*

C. F. Eckart, M. S., *Director of Division of Agriculture and Chemistry.*

The work of the Hawaiian Sugar Planters' Station has continued along the lines of previous years. The division of pathology and physiology has made a thorough study of the root disease affecting cane and measures have been formulated for effectively combating this fungus. Considerable attention has also been paid to cane diseases of lesser importance. The division of entomology has continued its efforts toward checking the ravages of the leaf hopper through the introduction and distribution of parasites. The efficacy of these methods has been strikingly demonstrated through a radical reduction of the damage by the hoppers, and while further work will be pursued along this line a large part of the time of the entomological staff will be concentrated on the eradication of the borer and other insects.

The division of agriculture and chemistry has confined its attention, as formerly, to questions dealing with the agriculture of cane and with sugar technology. A large part of the field work has been devoted to the propagation and selection of seedling canes. Numerous substations have been established on the various islands and tests are being conducted to determine the relative economy of dif-

ferent agricultural processes under special plantation conditions, and also the relative suitability of different varieties in diversified environments.

The income of the station during the past fiscal year was as follows:

Hawaiian Sugar Planters' Association	$65,517.72
Fees	7,842.97
Total	73,360.69

The publications of this station received during the year were as follows: In the division of agriculture and chemistry, Bulletins 13, Field experiments with sugar cane; 14, Irrigation experiments of 1905, and 15, Fertilizer experiments, 1897–1905; from the division of entomology, Bulletin 1, Parts 1–10, Leaf hoppers and their natural enemies; from the division of pathology and physiology, Bulletins 1, The inspection and disinfection of cane cuttings; 2, Preliminary notes on root disease of sugar cane in Hawaii, and 3, Gumming of the sugar cane; and the report of the station committee for 1905.

IDAHO.

Agricultural Experiment Station of the University of Idaho, *Moscow.*

Department of the University of Idaho.

H. T. French, M. S., *Director.*

The work of the Idaho Station has been seriously interfered with by the disastrous fire in March, 1906, which destroyed the main building of the university with most of the laboratories and collections and the library. The university authorities took steps toward rebuilding at once, and one of the new buildings under way is to be for the use of the agricultural department of the university and the station. In the meantime, notwithstanding the difficulties of the situation, considerable progress has been made by the station except in its laboratory work, and the investigations in several lines have expanded. The irrigation investigations in cooperation with this Office have been developed, especially on the cultural side, the investigations being confined very closely to questions relating directly to the use of irrigation water in the production of crops, with only secondary consideration of engineering problems. Considerable attention is to be given, as heretofore, to the study of general conditions and methods employed in the regions being opened up for settlement by new irrigation projects, as in the Snake River Valley; but efforts will be made to concentrate the more strictly experimental work at Caldwell in southern Idaho, where the station has secured a half section of land well suited to experiments in both dry and irrigation farming.

The station has successfully continued its demonstration work in spraying private orchards, and the results are being widely applied by fruit growers of the region.

Among other important investigations are studies of the nature and treatment of the San José scale, apple and elm aphis, pear blister mite, peach-leaf curl, and apple scab. There have also been experiments with a combination of Bordeaux mixture and arsenicals for apple scab and codling moth, with hot water versus formaldehyde for smut in oats, with formaldehyde for potato scab, with a treatment for the tomato blight which is doing serious injury to the canning business, with the injury to apples by applications of Bordeaux mixture at the time of blossoming, and with the carbon bisulphid treatment for squirrels.

The horticultural work of this station has been considerably developed during the year. Studies are being made of varieties of apples, pears, and plums, the marketing of apples, top grafting, grafting pears on quince stocks, breeding plums, mulching apples, cover crops, fertilizers for orchard fruits and strawberries, forest and fruit tree plantings, pruning, tests of a large number of varieties of tomatoes, cabbage, sweet corn, and strawberries, and a study of the methods of utilizing fruit by-products as in the manufacture of cider, vinegar, etc.

The work in agronomy has also been extended during the year and includes studies of several new rotations and of the use of manure, mainly with a view to finding a substitute for the bare fallow so generally practiced in the region. Tests and development by selection and crossing of corn and wheat, potatoes, flax, alfalfa, and other forage plants and grasses, sugar beets for seed, fall and spring seeding of grains, and field and pot experiments to determine the fertilizer requirements of Idaho soils have also been carried on.

In animal husbandry there has been a study of available feeds for cows and hogs, especially alfalfa and field peas. The breeding of a dual-purpose cow from Shorthorn stock is being continued, and a herd of Angora goats has been secured for use in clearing wild land.

The university has recently established a school of agriculture, which provides a four-year course preparatory to the regular college work. A four-year course in domestic science has also been added.

The publications of this station received during the year were: Bulletins 48, Raising calves on separator milk; 49, Soil temperatures 1903–4, a summary of weather data 1894–1904; 50, Trap rocks of Palouse region as road material, part 2; 51, Alkali conditions in the Payette Valley; 52, Potato scab; and 53, Experiments with wheat and oats for smut; a circular on weather data; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Balance from previous year	458.41
Farm products	1,460.71
Total	21,919.12

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Idaho Station is doing valuable work of a practical character. Through the agency of its publications, demonstration experiments, the organization of an agronomy association, and farmers' institute work it is exerting an important influence on the agricultural practice of the State. It is handicapped to some extent in carrying on advanced work by the difficulty of securing and holding well-equipped men.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, ***Urbana.***

Department of the University of Illinois.

Eugene Davenport, M. Agr., *Director.*

The Illinois Station has continued to receive generous appropriations from the State for special work upon practical problems, and the demonstration of the results. The live stock and soil investigations each receive $25,000, and the orchard, crop, and dairy investigations $15,000 each, making a total of $95,000. The work in these lines is planned with the aid of advisory committees chosen by the respective State associations, an arrangement which is found to be very successful and advantageous.

Experiments are carried out at various places in the State upon land rented from farmers for the purpose, rather than in direct cooperation with them, and practical demonstrations are made in dairying wherever the opportunity offers. This work is in addition to that at the station, but forms a quite prominent feature.

The department of agronomy has provided two additional fields during the year, one in Dekalb County on typical brown silt loam soil of the early Wisconsin glaciation, primarily for crop experiments, and the other in Whiteside County on soil typical of the deep loess silt, chiefly for soil investigations. Studies of the effects of crop rotation, legumes and catch crops, farm manure, phosphorus and potassium in various combinations are being undertaken on these fields. The work on soil fertility is carried out at the station and at about twenty-three other places in the State. A somewhat extensive

system of pot-culture experiments, to determine the depth to which plants feed, has been started during the year. Breeding experiments with wheat, oats, and clover have also been inaugurated, and corn-breeding experiments have been extended to cover a great variety of points, including the breeding of corn upon some of the poorer lands of the State. The laboratory for soil analysis has been enlarged, and some new and larger laboratories have been provided for investigations in farm mechanics (Pl. III, fig. 1), soil physics, and crop production.

Studies are being made with swine to determine the protein requirements, with sheep to determine the proper ratio of roughage to concentrates, and in fattening draft horses for market. The breeding of beef cattle of a dual-purpose type for economy of production is receiving attention, and studies of market conditions are continuing. A field agent is traversing the State to ascertain from actual observations leading problems in cattle feeding and to introduce improved methods. A building for swine feeding, costing about $2,000, has been completed.

The horticultural department is studying, with the aid of a chemist, changes in the composition of spraying materials after application, and is conducting a large amount of demonstration work with vegetables and fruits at various places in the State. Studies of the bitter rot, drainage, fertilizers, renovation, storage, etc., have been made with reference to local conditions in each case.

The dairyman is conducting feeding experiments to show the value of clover. He is meeting with good success in an endeavor to build up the station herd by the use of a high-grade Holstein bull. He is testing herds in the State, to show the differences in individuality of cows, and is also studying the milk supply of the larger cities.

During the year 5 bulletins, 12 circulars, and an annual report were received from the station, as follows: Bulletins 102, The construction of silos; 103, Comparison of methods of preparing corn and clover hay for fattening steers; 104, Field experiments and observations on insects injurious to Indian corn; 105, The farmer's vegetable garden; and 106, Spraying apples—relative merits of liquid and dust applications; Circulars 90, Sampling of milk for composite tests of individual cows; 91, 92, 94, and 98, Present methods of beef production; 93, Should dairy cows be confined in stalls? 95, Suggestions for the improvement of dairy barns; 96, Soil improvement for the Illinois corn belt; 97, Soil treatment for wheat on the poorer lands of the Illinois wheat belt; 99, The gist of 4 years' soil investigation in the Illinois wheat belt; 100, The gist of four years' soil investigation in the Illinois corn belt; and 101, Methods of testing variability in corn; and the Annual Report for 1905.

FIG. 1.—NEW FARM MECHANICS BUILDING, UNIVERSITY OF ILLINOIS.
[Approximately 100 feet square; cost, $32,000.]

FIG. 2.—INCUBATOR HOUSE, MAINE STATION.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	95,000.00
Fees	890.00
Farm products	708.84
Miscellaneous, including balance from previous year	1,418.91
Total	118,016.75

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Illinois Station is in a thoroughly prosperous condition. It is making a special effort to keep in touch with the farmers of the State, and the practical demonstrations in their midst, together with the farmers' institutes, special trains, and the like, have brought about their cordial support and confidence. In the further development of its work, researches of a more fundamental nature will doubtless be needed. Extension work through the college of agriculture continues to be vigorously developed, and a new instructor has been added to cover the subject of agriculture in the schools.

INDIANA.

Agricultural Experiment Station of Indiana, *Lafayette.*

Department of Purdue University.

Arthur Goss, M. S., A. C., *Director.*

The liberal State appropriations to the Indiana Station have enabled it to continue the expansion and development of its work, especially those phases relating to specific problems of rather immediate practical importance and demonstrations of crop improvement by better seeds and methods. Fertilizer, spraying, variety and plant breeding work has been carried on at the station, at county poor farms, and in a cooperative way with over 700 farmers representing all counties of the State. A number of very successful special trains have been run, besides farmers' excursions to the station. During the winter the station held a corn growers and stockmen's convention in the nature of a short course for farmers, lasting a week, with an attendance of about 1,200 farmers.

Among the investigations now under way are those by the botanical department of the plant rusts, particularly that of flax, for which the full life cycle has now been completed. The chemists have experiments in progress on rendering fertilizing materials available in the soil, and especially the effect of irrigation. The requirements of

muck soils have been studied, with results which indicate that the most needed element is potash.

A large feeding experiment with steers to compare the relative value of different roughages is being carried on, together with a similar experiment with pigs. A cross is being made of the Poland Chinas and Berkshires to increase fecundity. The dairyman is studying the efficiency of creaming by various systems prevailing on the farms of the State, the making of cottage cheese from pasteurized buttermilk, and methods of curing the same. Considerable work has been done by the veterinarian in the treatment of hog cholera and some attention has been given to the cornstalk disease.

The publications of this station received during the year were as follows: Bulletins 107, Agriculture at Purdue University; 108, Soy beans, middlings, and tankage as supplemental feeds in pork production; 109, Examination of horses for soundness; 110, Corn improvement; 111, Indiana plant diseases in 1905; and 112, Commercial fertilizers; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation[a]	25,000.00
Miscellaneous	14,657.45
Balance from previous year	3,306.12
Total	62,963.57

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

During the year the mailing list of the station was enlarged from 11,400 to 17,000 names, and the correspondence has also very largely increased. The station is getting into much closer relations with the farmers, and its work is becoming very popular. Owing to the character of the State appropriations and the present demands upon the station, there is some danger that its attention will be too largely absorbed by the immediately practical needs of the farmer, especially the demonstration to him of methods which are well known. The station has become, however, one of the active, aggressive stations of the Middle West in its work for improved agriculture.

[a] For the fiscal year ended October 31.

IOWA.

Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts.

C. F. Curtiss, M. S. A., *Director.*

Important changes in the plan of organization of the Iowa Station have been effected during the past year. The funds from the Adams Act and increased State appropriations have enabled a more clearly defined distinction between the experimental, instruction, and extension work than has formerly been the case. The general direction of the various lines of work in the college and station will still be under the heads of departments, but the assistants are in most cases assigned definitely to one field or the other. During the coming year twelve members of the staff will devote their time exclusively to station work. In addition the agricultural extension work, for which a State appropriation of $15,000 is available, has been organized as an independent department under the direction of the former agronomist and a corps of seven specialists. The total staff in the division of agriculture of the college and station now numbers 41. Among the recent additions is a photographer, whose time will be exclusively utilized for station work.

The work in agronomy has been subdivided into separate departments of farm crops, soils, and agricultural engineering. The farm-crops department has continued investigations for the selection and improvement of seed corn. The demand for its bulletin on this subject was so great that a second edition of 50,000 copies was published. The seed-corn trains were again sent out to all sections of the State and aroused much interest. Breeding experiments are under way with wheat, corn, alfalfa, clover, oats, and various grasses. The department of soils has completed a preliminary survey of the more important soil types in the State, and has conducted numerous cooperative experiments with farmers. Extensive studies of the physical and chemical characteristics of soils and of soil fertility are to be inaugurated. Farm engineering problems have included cooperative drainage investigations with this Office, studies of the use of alcohol for heat, light, and power, the draft of farm vehicles, and means for the storage and utilization of power from windmills.

The horticultural work of the station has been largely increased to include breeding experiments with various fruits, tests of hardy stocks and ornamentals, the winter storage of apples, and extensive spraying experiments. In this and similar work the station has again cooperated with the Bureau of Plant Industry and the State horticultural society and has conducted demonstration experiments with a number of county poor farms and individual farmers.

The equipment of a new dairy farm will provide for additional work in animal production. Extensive feeding experiments are now under way in pork production. Comparisons are being made between pasteurized and nonpasteurized milk with reference to the spread of tuberculosis, between whole and ground corn, and between corn, shorts, and tankage. The dairy section has carried on an educational butter test open to the creameries of the State, and has continued its work on the moisture content and keeping qualities of butter.

An investigation of commercial feeding stuffs by the chemical section and the State board of agriculture indicates the necessity of legislation regulating the sale of these products. The entomologist is making a mosquito survey of the State, and the botanist a plant-disease survey. Other work in these departments includes the life history of the codling moth and other insects, seed adulteration, the apple rust, and the bacteriological examination of water supplies.

Bulletins 81, Experiment in beef production; 82, The principal soil areas of Iowa; 83, Quack and wheat grasses; Some soil-binding grasses of Iowa; 84, The cedar apple fungi and apple rust in Iowa; and 85, Spraying calendar; and a revision of Bulletin 77, Selecting and preparing seed corn, have been received from the station during the year.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	31,509.36
Individuals	100.00
Farm products	9,821.82
Miscellaneous	1,515.76
Total	62,946.94

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedule prescribed by this Department and have been approved.

The Iowa Station is making decided progress and its outlook is exceedingly promising. Its policy of further differentiating the duties of the college and station staff should result in increased efficiency, especially in research, and through the extension staff the station should be in an excellent position to make its findings immediately available to the farmers of the State.

KANSAS.

Kansas Agricultural Experiment Station, ***Manhattan.***

Department of Kansas State Agricultural College.

C. W. Burkett, M. S., *Director.*

The work of the Kansas Station has been undergoing a radical reorganization. Increased responsibility has been given the newly appointed director, who will devote himself exclusively to administrative work. A policy of concentration of the lines of work has been outlined and it is hoped to bring about a better coordination of the several departments. The department of dairying and animal husbandry has been divided, the former head remaining in charge of the dairy work and his assistant taking up the work in animal husbandry. The Fort Hays substation has been placed in the immediate charge of the director, and is to be used largely for acclimation tests, plant breeding, feeding trials, field demonstrations, and studies in farm management.

The experiments in irrigation from wells which were carried on by the substation in cooperation with this Office have been concluded and reported upon. A tract of 40 acres has been leased near Fort Hays for cooperative experiments in dry farming.

An investigation of the nature and extent of adulteration of alfalfa seed and of a number of grasses has led to the development of a satisfactory method for detecting Canada blue grass in Kentucky bluegrass seed. An effort has been made to eradicate the San José scale, which has been discovered in several localities. Other work of the entomological department includes studies of insect pests of corn, alfalfa, and of stored grain. A large cooperative experiment in spraying apple trees for the prevention of apple scab and the ravages of the codling moth has been carried on by the horticulturist and a number of commercial orchardists. Several hundred acres were sprayed with Bordeaux mixture and either arsenate of lead or arsenate of soda, with the result that less than 25 per cent of the fruit was injured, whereas the year previous there was almost total loss.

Studies of cattle dips, extensive variety testing of grains and forage crops, breeding experiments with small fruits, and crop-rotation trials have been continued as in previous years. An egg-laying test of the leading breeds of hens, to include cost of production and similar factors, has been started and will continue a year.

An extensive study of wheat is to be undertaken, to include breeding experiments by the Svalof method and milling, chemical, and baking tests of Kansas wheat, with a view to studying the yield of flour and its baking qualities, especially as influenced by the proteid constituents. Experiments to ascertain the nutritive value of the

more important Kansas feeds will also be taken up, and studies of the causes and treatment of blind staggers and the efficacy of a remedy for hog cholera recently devised by the station.

The publications of this station received during the year were Bulletins 129, Kansas mammals in their relation to agriculture; 130, Steer feeding experiment VII, 1903–4; 131, Care of dairy utensils; 132, Western feeds for beef production; 133, Alfalfa seed, its adulterants, substitutes, and impurities and their detection; 134, The alfalfa seed crop and seeding alfalfa; and 135, Grading cream; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation for substations	15,000.00
Balance from previous year	679.19
Miscellaneous, including farm products	2,081.16
Total	37,760.35

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

A horticultural building has been completed, costing, with greenhouses and equipment, about $50,000. The college continues to increase very rapidly in size, causing very heavy demands for instruction work from the station men. Additional instructors are urgently needed to allow more opportunity for fundamental research work. In some cases problems of a more scientific nature could be substituted for the extensive field tests carried on at present to good advantage.

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the Agricultural and Mechanical College of Kentucky.

M. A. Scovell, M. S., Ph. D., *Director.*

The Kentucky Station continues to give much attention to tobacco investigations, partly by breeding experiments for the production of a leaf with smaller waste and with special qualities, and also by studies of the burn or wilt, which during the last two years has caused damage to at least 20 per cent of the crop while drying in the barn. An organism has been discovered which produces the disease when inoculated into the leaf, and its prevention is being studied in the field and in a specially constructed series of eight incubators, in which conditions of heat, moisture, and ventilation can be controlled at will. The latter will also be used in studies of the production of desirable

shades of color in curing. To determine the potash requirements of the crop, soil tests are in progress.

Clover diseases, especially "clover sickness," are receiving attention through cooperative experiments in several portions of the State. Temporary substations have been established at Hopkinsville and Bowling Green, 4 acres being under observation in each case.

Among lines of work continued as in previous years are soil investigations, including numerous analyses to determine the relations existing between their composition and the character of the crop; analyses of wheat, which seem to indicate that the kernels near the middle part of the head are richer in protein than those at the extremities, and of corn, in which in general the butts of the ears are richer; studies of insects infesting grain and young trees; nitroculture; Kentucky weeds; bee keeping; and the value of artificial shade for vegetables.

The chemist is making a study of the availability of soil constituents as determined by fifth-normal nitric acid. A department of animal husbandry has been established, in charge of E. S. Good, of the Illinois Station.

A feed-inspection law was passed by the last legislature, which is expected to yield from $10,000 to $12,000 a year to the station. An appropriation of $10,500 is available for food inspection and the fertilizer inspection yields about $23,000. Fees are charged for the nursery inspection sufficient to cover actual expenses, while the seed inspection is performed gratis. The inspection work, as a whole, is increasingly heavy, but interferes very little with the station work.

During the year the following publications have been received from this station: Bulletins 117, 121, and 123, Analyses of commercial fertilizers; 118, Corn—field tests; 119, Labels on adulterated and imitation foods; 120, Some tree and wood infesting insects; cabbage snakes; 122, Corn; 124, On the adulterants and weed seeds in Kentucky samples of blue grass, orchard grass, timothy, red clover, and alfalfa seeds; 125, Observations and experiments on clover, alfalfa, and soy beans; and 126, Soils; and the Annual Reports for 1901 and 1902.

The income of this station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	10,498.49
Balance from previous year	3,478.59
Fees	22,924.23
Farm products, including the balance from previous year	6,965.88
Miscellaneous	1,552.12
Total	65,419.31

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The extension work in this State is chiefly in the form of farmers' institutes, for which a State appropriation of $2,000 is available. The station is well equipped and enjoys the hearty support of its constituents.

LOUISIANA.

No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
No. 2. State Experiment Station, *Baton Rouge.*
No. 3. North Louisiana Experiment Station, *Calhoun.*

Department of Louisiana State University and Agricultural and Mechanical College.

W. R. DODSON, A. B., B. S., *Director, Baton Rouge.*

The Louisiana stations have completed a study of the composition of the roots, stems, and leaves of sugar cane at definite stages of development and at maturity. The results are of service in dealing with problems in clarification of cane juices and in the handling of products in the sugarhouse, and will furnish much valuable data for future investigations. The germination of seedling canes, the value of deep preparation of the soil, and the fermentation of sugarhouse products for the manufacture of alcohol are now receiving attention.

The veterinarian has brought to a close his investigations on the nodular disease of the intestines of sheep. He concludes that by keeping them in lots cleared of vegetation up to the time of weaning, lambs from infected ewes may be raised practically free from the disease. Investigations recently inaugurated include a study of the influence of stable manure and fertilizers on the quality of sirup made from cane in north Louisiana and of methods for improving the grapes, apples, and peaches of the vicinity. Poultry breeding has also been begun, numerous feeding experiments with cattle and hogs are being conducted, and rice investigations are under way at Crowley. Considerable time is required for the State fertilizer and feed inspection, which under a law recently passed is expected to net the station about $5,000 a year additional revenue. The director remains in charge of the State geological survey, and is a member of the Crop Pest Commission which is investigating the cotton boll weevil.

The additional funds provided by the Adams Act have been used in the employment of a research chemist for investigations on the carbohydrates of cane-sugar products and the purchase of equipment for work in animal and plant pathology. Specialists have been engaged in both these lines.

The station staff has taken part in the farmers' institute work, taught at the summer normal school for teachers, and accompanied an industrial train run by one of the railroads, delivering addresses on farm topics along the route. The equipment and buildings of the North Louisiana Station have been greatly improved (Pl. V, fig. 1).

The following publications of the stations have been received during the past fiscal year: Bulletins 80, Analyses of commercial fertilizers and Paris green; 81, Results of experiments in production and marketing fruits and vegetables, and canning fruits and vegetables on a small scale, at the North Louisiana Station; 82, The Texas fever cattle-tick situation, and the eradication of the tick by a pasture rotation system; 83, Results of further experiment with nodule disease of the intestines of sheep—the "bare-lot" method of raising lambs; 84, Texas fever; and 85, Blackleg; Bulletins of the Lousiana geological survey: 1, Underground waters of Louisiana; 2, Terrestrial magnetism and meridian-line work; and 3, Establishment of tide-gauge work; and the Annual Reports for 1904 and 1905.

The income of the stations during the past fiscal year was as follows:

United States appropriation, Hatch Act	$1,500.00
United States appropriation, Adams Act	5,000.00
State appropriation	15,000.00
Balance from previous year	15,612.33
Refund	550.00
Farm products	3,385.33
Miscellaneous	3,332.26
Total	57,879.92

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Louisiana stations are devoting their attention more largely to research investigations, and the increased funds at their disposal will enable them to extend their fields of usefulness along several new lines. A progressive policy is being followed and should yield results of decided scientific and practical value.

MAINE.

Maine Agricultural Experiment Station, *Orono.*

Department of the University of Maine.

C. D. Woods, Sc. D., *Director.*

The Maine Station continues to make a special feature of its poultry investigations, which, as carried out during the year, have included questions in both breeding and management. A comparison of the chick-producing capacities of eggs from hens that had been

mated for several months, with those from recent mating, demonstrated the entire fitness of long-mated birds for breeders, and monthly tests of eggs from the same pen showed no decrease in the fertility of eggs after the hens had been laying steadily for five months. Early laying was found in general to be a reliable indicator of good laying qualities. Investigations in progress include the selection of breeding stock by the use of trap nests, studies of how large a flock should be, how much floor space each fowl should have, and a comparison of cut clover and mangolds as a part of the ration. A residence for the poultryman has been erected at a cost of about $1,800, the basement of which is occupied as an incubator cellar, with space for sixteen incubators (Pl. III, fig. 2).

The nutrition investigations in cooperation with this Office have consisted largely of digestion experiments with corn meal. The results indicate thorough digestibility and comparative ease of digestion.

The entomologist has published reports on the cottony grass scale and the strawberry girdler, and is now working chiefly on plant lice, their life history and relation to crop injury. A small insectary has been built and equipped and the library, which was hitherto poorly provided with entomological books, has received liberal additions.

As a result of the passage of the Adams Act the department of horticulture has been replaced by departments of pomology and vegetable pathology, W. M. Munson, the former horticulturist, becoming pomologist and W. J. Morse, of the Vermont Station, being appointed pathologist. The station has taken up work in seed inspection and has published one bulletin giving analyses.

The university has withdrawn almost entirely from the station building, thereby affording the station enlarged quarters. A granite building is being erected for a university library, for which Mr. Andrew Carnegie has given $50,000 besides $5,000 for equipment.

Increasing attention is being given to extension work. Reading and correspondence courses in sixteen topics are now offered, and a beginning has been made in introducing the study of agriculture and horticulture into the normal schools. A "better farming special" train was run with the aid of the station, which was visited by over 20,000 people and proved a great success.

The publications of this station received during the year were the Annual Reports for 1904 and 1905 and Bulletins 116–129, as follows: 116 and 119, Food inspection; 117, Poultry experiments; 118, Cereal foods; 120 and 127, Fertilizer inspection; 121, The cottony grass scale; 122, Experiments in orchard culture; 123, The strawberry crown girdler; 124, Finances, meteorology, index; 125, Seed inspection; 126, Field experiments in 1905—The effect of the ration

on the value of the manure; 128, Orchard notes; and 129, Feeding-stuff inspection.

The income of the Station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Inspectors' fees, sales, etc	8,407.36
Balance from previous year	1,108.80
Total	29,516.16

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Maine Station is in better position than ever before to do a considerable amount of thorough work. It has secured the confidence and support of the farmers by the practical work done in spraying and inspection and by the cooperative experiments. Under its present organization its work is more clearly differentiated from that of the college, and it is the desire to separate the inspection and other routine duties as thoroughly as possible from the work of investigation. The outlook for its greater success in the future is therefore promising.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

H. J. PATTERSON, B. S., *Director.*

The work of the Maryland Station has continued along the lines of previous years, although there has been some interruption because of numerous changes in personnel. The poultry and dairy investigations, temporarily suspended from this cause, have been resumed. The horticulturist has been succeeded by C. P. Close, of the Delaware Station, and V. M. Shoesmith, of the Kansas Station, has recently taken up the work in agronomy. A number of additional assistants have also been provided, including an assistant in demonstration work.

In agronomy attention has been chiefly directed to corn breeding and tests of cowpeas. Trials of alfalfa showed it to be well adapted to Maryland conditions. An effort is to be made to develop wheat-breeding experiments on an extensive scale.

The chemist has been making studies on the digestibility and feeding value of some sugar foods, particularly molasses. Sweet-corn breeding work is being continued by the assistant chemist, the object being to secure a grain with higher sugar content and better adapted

to canning purposes, and also a variety which will give higher yields. Some phases of this work are being conducted in cooperation with the Bureau of Chemistry of this Department. Feeding experiments and fertilizer trials are being continued.

In horticulture the principal investigations of the year were on the picking, packing, storing, and marketing of fruits, particular attention being given to the marketing of peaches. The horticulturist accompanied various shipments to a number of large markets in order to determine the relative value of different methods of packing and marketing. Cooperative studies are being carried on in various parts of the State to determine the effect of potash salts on apples, peaches, pears, and plums. The effect of frost on fruit buds is also being studied, and investigations have been made of nitrocultures for beans and peas.

The veterinarian is continuing his studies on spinal meningitis and the von Behring method of immunization against tuberculosis. He is also studying the rôle of leucocytes and their relation to disease and its control.

The departments of botany and entomology are occupied chiefly with State inspection work, but some investigations are proceeding on the cause of diseases, life history of insect pests, and remedies.

The publications included a report and six bulletins. Those received during the fiscal year were as follows: Bulletins 100, The wild legumes of Maryland and their utilization; 101, Common injurious and beneficial insects of Maryland; 102, Leucocytes in milk and their significance; 103, Method of tobacco seed selection; 104, Tests of materials for bedding cows; 105, Experiments with fumigating nursery stock; 106, The influence of the size of the grain and the germ of corn upon the plant; 107, 1905 Spraying experiments for the San José scale; and 108, Irish potato diseases.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	10,000.00
Farm products	5,182.63
Balance from previous year	1,208.21
Total	36,390.84

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The mailing list now numbers about 20,000, being 46 per cent more than that of eight years ago, and the correspondence is increasingly heavy. The State has recently shown a disposition to come more

largely to the support of the station. A poultry plant has been provided, and construction will soon begin on new barns for dairy and feeding work. While suffering somewhat from the numerous changes in personnel, the station has made progress in the better differentiation of its work from that of the college and by its adherence to the policy of restricting its investigations to a few definite lines of work.

MASSACHUSETTS.

Massachusetts Agricultural Experiment Station, *Amherst.*

Department of the Massachusetts Agricultural College.

W. P. Brooks, Ph. D., *Director.*

During the year the organization of the Massachusetts Station has been given more definite form by the election of a director distinct from the office of president. A division of veterinary science has been established, in charge of the college veterinarian. The station has entered into cooperation with the Bureau of Plant Industry and local growers in a study of cranberry growing on Cape Cod, and is carrying on cooperative fertilizer trials with asparagus at Concord in an endeavor to produce a more rust-resistant type.

Some interesting observations are under way on the physical constants—heat, light, etc.—in relation to plant and insect development. The botanist has nearly completed studies of light intensity and measurements of the light units used by plants, together with the bearing of these points on construction of greenhouses, exposure and related problems. He is also continuing his work on electricity both as regards its influence on plant growth and its stimulating effect on bacteria. The horticulturist has taken up the heat and light requirements of different stages of plant growth, using the cress as a type. In entomology, the heat units required for the metamorphosis of different insects are being worked out as a guide to determining the date of their appearance.

The botanist is still investigating the diseases of greenhouse crops and the injuries to shade trees by illuminating gas, banding substances, and other agencies. Seed testing for onion and tobacco growers has been taken up, and a pure culture of yeast has been prepared for trial in the production of a medicinal wine from the cranberry. Experiments with soils of different textures as related to the germination and growth of plants have also received attention.

The horticulturist has developed a collection of dwarf fruit trees which attracts much notice. He is also studying the Mendelian and Galtonian laws of variation on squashes and nasturtiums, the effect of stock and scion in grafting, and pruning with reference to development of a system. The entomologist, aside from the work mentioned above, is testing proprietary sprays and studying the relative

susceptibility of plants and insects to hydrocyanic acid and other insecticides.

Feeding and digestion experiments have been carried on with cattle which indicate that the feeding value of Porto Rico molasses for dairy stock is about 80 per cent that of corn meal. With sheep, digestion coefficients have been obtained for a number of by-products and forage crops. An experiment has also been completed to show the physiological and economic value of protein in milk production. The inspection of fertilizers, feeding stuffs, nurseries, etc., continues to occupy considerable time.

During the year the college and station have continued to prosper and have made numerous additions to equipment. The horticultural building has been occupied, and the new college barn is nearing completion. An addition to the insectary and a new greenhouse have provided increased facilities for the entomologists, and a new building for the department of botany and vegetable pathology is under construction. This building, which will be called Clark Hall, will be designed for the special needs of both the college and station work, and will cost, without equipment or greenhouses, about $45,000.

The most important step in extension work was the participation of the college and station in the equipping and management of the first railway special to be operated in New England in the interests of agriculture. The "Better farming special," which traversed a considerable part of the State and later portions of Vermont and New Hampshire, attracted much attention, there being at least 10,000 visitors in Massachusetts, of whom a noticeably large proportion were young people.

The publications of this station during the year were as follows: Bulletins 103, 104, and 107, Analyses of fertilizers; 105, Tomatoes under glass, methods of pruning tomatoes; 106, Condimental stock and poultry foods; 108, Inspection of concentrates; and 109, Analyses of fertilizers and insecticides; Meteorological bulletins 198 to 209; and an index to Massachusetts Station publications, volumes 1 to 12, 1883 to 1894.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$14, 617. 70
United States appropriation, Adams Act	5, 000. 00
Balance of United States funds from previous year	382. 30
State appropriation	13, 500. 00
Fees	4, 745. 00
Farm products	2, 836. 02
Miscellaneous	4, 993. 76
Total	46, 074. 78

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

There are many indications of an increasing interest in agricultural affairs in this State. The last legislature appropriated $5,000 for normal work at the college as the result of the report of an industrial commission appointed by the governor. An agricultural department of a high school was opened at Petersham in charge of a recent graduate from the college. The demands on the college and station are steadily increasing, and they enjoy the cordial cooperation and support of the people of the State. The station is doing a large amount of work of scientific value, together with much of more immediately practical importance. Its outlook, with a director at its head to give a large share of his attention to its interests, seems very encouraging.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, *Agricultural College.*[a]

Department of Michigan State Agricultural College.

C. D. Smith, M. S., *Director.*

The work of the Michigan Station is progressing along practically the same general lines as formerly. Some strong work is being done in agricultural bacteriology on the effect of various organisms, alone and associated, on rendering the phosphates available in the soil, the effect of different amounts of green manure with soil on development of acid, the organisms of nitrogen assimilation by legumes, etc. Studies of the associative action of bacteria with certain combinations in connection with lactic-acid organisms in souring milk have shown differences of as much as ninety-six hours in the time of souring.

The field work is being carried on much as in previous years, and includes a wide variety of culture, fertilizer, breeding, and variety tests. The study of the effect of inoculation on the composition of peas and other legumes is continued. Some improved strains of oats and wheat which have been distributed through the State are giving excellent results and receive many compliments from farmers and millers. An investigation of mint growing has been begun, both as to the culture of the crop and the extraction of the oil. To this end fertilizer trials have been conducted upon large mint fields near Kalamazoo, and studies are progressing as to the diseases of mint.

The department of animal husbandry has been making experiments with substitutes for skim milk for hogs, and also with cull beans,

[a] Freight and express address, *Lansing.*

soiling crops, beets, etc. Work is going on with grade dairy cows bred to Holstein, Jersey, Guernsey, and Shorthorn bulls. The station now has the first generation of progeny, and it is believed that in four generations animals can be produced practically equivalent to pure breds. The department is doing some work with beef cattle and sheep, and is also raising calves in different ways. Experiments on the amounts of unground corn and oats voided by cows, heifers, and calves showed that from 20 to 26 per cent of the material passed through the digestive tract undigested, indicating that the feeding of grain without grinding can seldom if ever be economical. Dried beet pulp is being fed as a substitute for silage, and cooperative experiments are under way with farmers in the use of beet pulp for cows as a supplement to failing pastures.

The horticultural department has begun the selection of strains of potatoes resistant to blight. Studies of the cross pollination of varieties of apples and pears have been continued, as have also those of the pollination of strawberries as a means of improving the shipping qualities and prolonging the season. There is some work with fertilizers, catch crops, and tillage of orchards, and cooperative spraying trials for grape rot, San José scale, and potato rot are proceeding at several points in the State.

During the past year the following publications of this station have been received: Bulletins 225, Alfalfa in Michigan; 226, The work at the substations; 227, Legumes other than alfalfa; 228, The discussion of the milk problem from the standpoint of production; 229, A popular review of special Bulletin No. 33; 230, Some bacterial diseases of plants prevalent in Michigan; 231, Suggestions concerning legume inoculation; 232, Fertilizer analyses; 233, Insects of the garden; 234, Feeding dairy cows; 235, Succotash as a soiling crop; 236, Spraying for potato blight in 1905; and 237, Digester tankage for swine; Special Bulletins 32, Investigation regarding succulence; 33, Extended studies of the associative action of bacteria in the souring of milk; 34, Corn improvement; and 35, Report of the South Haven Substation for 1905; and the Annual Report for 1905.

The mailing list now numbers 43,000 and is continually increasing. The cost of the publications is borne by the State.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation for substations	15,530.17
Fees	2,860.00
Farm products, including substations	2,610.10
Balance from previous year	1,259.27
Total	42,259.54

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Michigan Station is doing a large amount of work for the improvement and development of the agriculture of the State, and has a strong hold on its constituents, with whom it maintains very close relations. A conservative policy is being pursued which is resulting in a fortunate combination of directly practical work with the more thorough investigations.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of the University of Minnesota.

W. M. Liggett, *Director.*

At the Minnesota Station, the department of agricultural chemistry has been expanded to include a new division dealing with soils and fertilizers. The work with soils will be largely confined to a study of soils of reduced fertility and means for their improvement, especial attention being given to the organic constituents. A ten-year series of field tests has shown that rapid and heavy losses of humus and nitrogen result under exclusive grain farming, while under stock farming and crop rotation these losses are minimized. The frequent shriveling of cereals, which has been attributed to drought, frost, and other factors, has in many cases been found to be a direct result of unbalanced fertilizers. Studies have been begun on the digestibility and feeding value of emmer, the protein content of various forage crops, and chemical methods of determining available plant food versus actual field check experiments. Nutrition work has been continued in cooperation with this Office, the principal studies being investigations of the digestibility and nutritive value of flour when prepared in other forms than bread, such as crackers, biscuits, pancakes, and cookies.

The veterinarian has been making extensive investigations of the physiological aspects of stable ventilation. It is found that steers of sound health can be subjected to close confinement and a high carbon dioxid content in the air without apparent injury, and the conclusion is drawn that the importance of ventilation is from hygienic considerations and as a preventive of the spread of contagious diseases, rather than because of any deleterious influence of an excess of carbon dioxid itself. Studies have also been made of the means of transmission of tuberculosis, and about seventy calves have been inoculated with von Behring's tubercle vaccine to determine immunity. Under

a special Congressional appropriation a study of hemorrhagic septicemia will be made in cooperation with the Bureau of Animal Industry.

Extensive plant breeding experiments have been continued, especially with durum wheat, oats, flax, and barley. A series of crop rotation and farm management experiments is proceeding in different parts of the State in cooperation with former students of the school of agriculture and the Bureau of Statistics. The main object is to determine the lines of farming most profitable for the various parts of the State, and valuable data have been secured as to the cost of production of farm crops and the income of farms.

Feeding experiments with milch cows have been continued upon the relationship between the maintenance requirements and those for milk production, and experiments have been undertaken with cattle, sheep, and swine, with a view to ascertaining the influence of breeding and feeding on the value of the finished products. The entomologist has given special attention to bee keeping and to an investigation of the cabbage maggot.

An administration building for the agricultural department of the university, costing about $200,000, is nearing completion, which will furnish quarters for the director of the station and the departments of agriculture and entomology. An insectary, costing $2,500, has also been erected. Special State appropriations of $4,500 for the purchase of live stock, $4,000 for experiments in plant breeding, and $1,000 for soil investigations, have been available.

The following publications of this station were received during the year: Bulletins 92, The digestibility and nutritive value of cottage cheese, rice, peas, and bacon; and 93, The diptera of Minnesota—two-winged flies affecting the farm, garden, stock, and household; and the Annual Report for 1904.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation, including substations	37,189.18
Farm products, including substations	11,188.21
Total	68,377.39

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Minnesota Station, from a material standpoint, is in a very flourishing condition, and its influence for good is being widely recognized. The support given it by the State is very encouraging and the extensive cooperative enterprises between the station, former student organizations, and others show a considerable widening of its sphere

of influence. The rapid increase in the attendance at the school of agriculture of the university, and the agricultural high schools, is evidence of greater interest in improved agriculture, and the station will doubtless still further profit from this condition.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*[a]

Department of Mississippi Agricultural and Mechanical College.

W. L. Hutchinson, M. S., *Director.*

The Mississippi Station has continued its investigations on the improvement of agricultural practice in the South. Under existing conditions it is estimated that the labor of two men and a mule is barely sufficient to produce crops which, aside from what is consumed on the premises, will yield a cash income of $200 a year, and even under this system the productiveness of the soil is being steadily diminished. With the proper equipment and improved methods, however, it is believed that one man can make the same amount of land mainly self-supporting, maintain the fertility of the soil, and sell from $500 to $2,000 worth of product annually. Efforts are being made by the station to introduce more diversified farming as a means to this end. The department of animal industry, recently established, has carried on feeding experiments which indicate that beef production may be made a profitable industry. Preparations are being made further to develop the work in poultry raising, dairying, and agronomy. Pure-bred stock is to be bought and experiments made with a larger number of animals. One problem to be undertaken is that of the better utilization of pastures and woodlands in the State, so that a larger number of animals can be maintained per acre.

During the year the college and station farms, gardens, and dairies have been consolidated under the station management. The agronomist, who has recently returned from a year's leave of absence spent in advanced study, will have general charge of the work with farm crops. About 150 acres are now available for experimental purposes and will be devoted largely to investigations of methods of cultivation, fertilizers, rotation of crops, the growing of forage crops, and plant-breeding experiments. A new dairy building, costing about $10,000, has been completed. This is a brick structure, consisting of two stories and basement. It contains ample room for the growth of the dairy department, and special provision is made for work in bacteriology.

[a] Telegraph address, *Starkville;* express and post-office address, *Agricultural College;* freight address, *A. and M. College Station.*

The horticultural work is being enlarged and an additional assistant has been employed. Experiments with grapes will be renewed and variety tests of pecans and other nuts will be extended.

The three substations supported by State funds are proving of much value to their respective localities and an aid to the cause of station work in the State. The McNeill substation, located in the pine-woods area, has demonstrated that large crops of forage plants, such as vetch and cowpeas, may be economically grown and used to maintain a much larger number of stock than is done at present. At Holly Springs vetch has been found a valuable crop in the reclamation of badly worn soils. Striking results were obtained from inoculation. The problems at the Delta substation include drainage, breaking up of compact soils, the restriction of the cotton area, the growing of corn, alfalfa, vetch, bur clover, etc., and the pasturage of hogs.

The following publications have been received during the year: Bulletins 85 and 91, Inspection and analyses of commercial fertilizers; 87, Report of work at McNeill branch experiment station for 1904; 88, Report of field work done at the college station for 1904; 89, The underground waters of Mississippi; 90, The San José scale in Mississippi, and the lime-salt-sulphur wash; 92, Feeding beef cattle in Mississippi; and 93, Peach and plum culture.

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation for substations	9,000.00
Farm products, including substations	4,260.89
Miscellaneous, including balance from previous year	13,352.88
Total	46,613.77

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with schedules prescribed by this Department and have been approved.

The summer school and institute held at the college again met with good success. Agriculture is being taught in the public schools, and there is an agitation for secondary agricultural education as a means of relieving the present overcrowding in the college preparatory department, which now numbers 300 students. Appreciation of the work of the college and station is increasing. The equipment is being materially augmented, and there is much activity in making plans which, if carried out, will undoubtedly further increase their efficiency and usefulness.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

H. J. Waters, B. S. A., *Director.*

From an extensive series of feeding experiments with cattle the Missouri Station concludes that the condition of the animal is a more important factor in the cost of gain than is age, and that if animals are fully fed, have fresh air, and a comfortable place to lie, warm quarters seem unnecessary. Calves, yearlings, and 2 and 3 year olds fed an optimum of grain approximating very closely the limit of the appetite of the animal have made gains at the minimum of cost in feed. The addition of a supplement like linseed or cotton seed meal to a basal ration of corn has resulted in economy in the cost of production, the animals being better finished and selling at an increase more than sufficient to meet the additional cost. Roughage crops rich in protein, such as the legumes, have proved decidedly superior for beef production and wintering to nonleguminous roughage. These experiments are to be continued on a large scale.

Another important series of feeding experiments is being carried on with pigs. Experiments with feeding lecithin indicate that its physiological significance depends wholly upon its phosphorus content, and the function of phosphorus has been shown to be in direct connection with muscle formation rather than in fat production, as commonly supposed.

In cooperation with the Bureau of Animal Industry an elaborate study of dairy products has been inaugurated. The composition, physical structure, and general qualities of milk from different breeds will be investigated throughout the entire period of lactation. An organism causing bitter milk has been isolated. The veterinarian has been making a test of the changes of temperature and of the blood of cows during lactation, and is also investigating serum treatments for hog cholera, tuberculosis, and the distribution of blackleg, which in epidemic forms seems to be associated with certain types of soils accompanying crop conditions.

A soil survey of the State is being made through a thorough and systematic study of soil types. In addition to the usual observations, field experiments are to be carried on for each of the important types to ascertain methods of improvement. One year's results have already been obtained from ten substations, three having been located for the study of underdrainage, and negotiations are in progress for three others.

The cooperative and extension work of the station with the farmers of the State has assumed large proportions. Over 100 farmers, representing nearly every county, have devoted from 4 to 10 acres to an experiment for corn improvement, and over 500 boys from 10 to 20 years of age have grown pedigreed corn in a contest under the direction of the station. Premiums aggregating $500 have been offered for the best exhibits at the State Corn Growers' Convention to be held at the college and at the State fair. A number of apple orchards on typical soils have been secured for a systematic study of the fertilizer requirements, and through the cooperation of the Missouri Pacific Railway a poultry-farming train is to traverse the State.

During the year a cattle barn for beef animals has been completed at a cost of $12,000, a hog barn costing $2,000, and a stone structure for instruction and research in farm mechanics costing $5,000. A greenhouse for the botanist is to be erected. Numerous additions have been made to the station staff, and Dr. Paul Schweitzer, chemist for many years, has retired from active service.

The publications of this station received during the year were as follows: Bulletins 66, Analyses of commercial fertilizers; 67, Supplements to corn for fattening hogs; 68, Test of tin-can separators; Test of a fly repellant; and 69, Three fungus diseases of the cultivated ginseng; and a circular on some fungus diseases and their treatment.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	4,000.00
Fees	6,102.66
Farm products	5,644.48
Balance from previous year	492.87
Total	36,240.01

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Missouri Station has a large amount of valuable work under way, and some of its new lines are especially promising. The great demand upon it for institute and other extension work shows an increasing appreciation on the part of the public. The policy recently adopted of relieving the station men from as much of the teaching and routine work as possible is yielding good results, and the station is now thoroughly organized for aggressive research work.

Missouri State Fruit Experiment Station, *Mountain Grove.*

PAUL EVANS, *Director.*

The work of the Missouri State Fruit Experiment Station has continued to be devoted chiefly to the development of the fruit interests of the southern part of the State. Particular attention has been given to the use of commercial fertilizers in fruit and vegetable growing.

The station is supported entirely by State appropriations. For the past fiscal year $20,650 was available. Bulletins 13, on Commercial fertilizers, and 14, Preliminary experiments in dipping nursery stock, were the only publications received during the year.

MONTANA.

Montana Agricultural Experiment Station, *Bozeman.*

Department of the Montana College of Agriculture and Mechanic Arts.

F. B. LINFIELD, B. S. A., *Director.*

The past year at the Montana Station has been one of development along several lines. Seven dry farms have been established in the principal sections of the State, and experiments with cereals, sugar beets, potatoes, flax, alfalfa, brome grass, etc., have been begun. Notwithstanding unfavorable conditions during the past two seasons, good results have been obtained. In this connection the localization of rainfall with reference to the probable success of dry farming is being studied. The work in dry farming is in cooperation with the farmers of the State. The expense has been met in part by a special State appropriation and in part by contributions from the Northern Pacific and Great Northern railways.

Irrigation and drainage investigations have been extended at the station and at different points in the State. Special attention has been given to the drainage of seeped lands, the use of seepage water for irrigation, the prevention of seepage from ditches by cementing, and the pumping of water with windmills and engines for supplementary irrigation. With a view to developing a department of agricultural engineering the title of the head of the department has been changed and an assistant has been appointed.

The work in botany, zoology, and entomology has been merged in a new department of biology, with the former entomologist at its head. An assistant botanist has been added, who will give special attention to plant diseases, a field heretofore undeveloped. A new insectary has been erected.

The sugar-beet investigations, in cooperation with a number of farmers, have shown that this crop can be successfully grown in

many parts of the State. A factory has just commenced operations at Billings, and others are being planned elsewhere. Tests have been made of a large number of varieties of wheat, barley, oats, potatoes, and forage plants with and without irrigation, and some attention has been given to fertilizer experiments, rotations to conserve fertility, the rate of seeding and nurse crops for alfalfa and seed production with cereals. A cooperative test of the acclimation of corn has been made in the Yellowstone and Bitter Root valleys. A well-equipped soil physics laboratory has been provided for the agronomy work.

The chemical work of the station has been confined mainly to tests of quality of the sugar beets grown in different parts of the State, studies of poisonous plants, methods of treatment of locoed sheep, and miscellaneous analytical work. In dairying some investigations have been made as to the effect of age on the yield, quality, and character of the butter fat, and on the comparative influence of rennet and cheese pepsin on the yield, texture, and quality of cheese. The breeding up of ordinary Montana cattle has also been undertaken. The horticultural work has included the domestication and improvement of some of the native fruits, the enlargement of the nurseries and fruit plantations, the thinning of fruits, the effect of staking on the maturing of tomatoes, and the transplanting of onions. About 5 acres of additional land has been purchased for this department, increasing its ground to about 15 acres.

The facilities in animal husbandry are being steadily improved. During the past year there were carried on experiments in pasturing cattle, testing the economy of grain in feeding cattle and sheep, and supplementing grain with clover, tankage, and skim milk in feeding pigs. Some work in pig breeding has been undertaken, the poultry plant has been enlarged, and an additional assistant has been appointed.

The publications of this station received during the year were Bulletins 56, Native economic plants of Montana; 57, Pig feeding experiments; 58, Steer feeding experiments; 59, Sheep feeding, 1903–4 and 1904–5; and 60, Onion growing in Montana; and the Annual Report for 1904.

The income of the station during the past fiscal year, besides funds contributed by the State and corporations for the experiments in dry farming, was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	5,424.44
Farm products	4,825.62
Total	30,250.06

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The work of the Montana Station is expanding in many useful directions, and, through publications, local cooperative work, farmers' institutes and other farmers' organizations, is being brought into touch with agricultural interests all over the State. Its correspondence continues to increase very rapidly. The State and private corporations show a disposition to extend liberal aid.

NEBRASKA.

Agricultural Experiment Station of Nebraska, ***Lincoln.***

Department of the University of Nebraska.

E. A. Burnett, B. S., *Director.*

At the Nebraska Station a considerable number of changes have taken place in the staff. The resignation of T. L. Lyon, agronomist and associate director, to accept a position at Cornell University and Station, was followed by the division of the department of agronomy into departments of soils and field crops. F. J. Alway has succeeded S. Avery as chemist. Forestry has been added as a new department, and experimental work in botany has been begun. Additional assistants have been provided in several departments.

In the animal husbandry work cattle feeding has again been made the leading feature, particularly as to the relative value of a number of forage crops. The most economical ration for Nebraska has been found to be alfalfa, corn stover, and corn. Experiments in pig feeding are also being conducted. A barn for this purpose is being constructed, and the cattle barn has been remodeled.

In horticulture demonstrations in spraying in cooperation with the Bureau of Plant Industry are being carried on in several localities. Experiments in breeding hybrid apples and peaches are under way. Variety tests with vegetables, which have been carried on for several years, have been concluded, as have also extensive experiments in the selection and propagation of seed potatoes. An assistant has been provided in this department.

The recently established department of botany has been equipped and studies have been made, jointly with the veterinarian, of poisonous plants and of moldy corn in relation to diseases in horses. The mold, which seems to be unlike any heretofore reported, is quite destructive to the crop, causing a loss of about 60 per cent in the weight of the defective ears, and is believed to be the cause of death of a considerable number of horses. The botanist is also studying a monilia disease of apples that produces an unusual form

of black rot, and the cedar rust in which he has found evidence of a perennial mycelium, a fact not hitherto attributed to this species.

In the department of soils all experiments previously inaugurated have been continued, together with studies of soil fertility, humus, drainage, and the removal of alkali. From several years of wheat breeding sufficient seed has been obtained from individual plants of merit to give a field test on one-tenth acre plats of about 200 varieties. Corn breeding is also a leading feature, and tests of wheat, corn, soy beans, oats, and other crops are proceeding with about 1,800 farmers.

The chemist has completed an investigation on the bleaching of flour with nitrogen peroxid, and finds that the coloring matter is closely associated with the oil content of the flour. An experiment under his direction as to the value of copper sulphate as a preventive of hog cholera demonstrated its worthlessness, large quantities being fed for six weeks without securing any immunity from the disease. Malarial fever in horses is receiving attention from the veterinarian and several departments are cooperating in studying the loco disease.

The substation at North Platte is under the immediate charge of the director and is being used largely for demonstration experiments. Some work in plant breeding, and irrigation investigations in cooperation with this Office, have also been taken up. About $12,000 has been expended for permanent improvements. The State makes an appropriation of $10,000 per year for this substation.

Bulletins 89, Winter wheat; 90, Cattle-feeding experiments; and 91, Experiments with corn, were received during the year from this station.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation for substation	10,000.00
Farm products	14,575.67
Balance from previous year	1,818.76
Total	46,394.43

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The completion of the agricultural building has provided increased accommodations for the station as well as for the college and school of agriculture. Extension work is being vigorously conducted by special trains, boys' and girls' associations, and other ways. The biennial appropriation for farmers' institutes is $12,000. The station is in a prosperous condition, and is expanding and developing its

work along useful lines. It is growing in support and appreciation, and is rendering increasingly valuable service to the agriculture of the State.

NEVADA.

Nevada Agricultural Experiment Station, ***Reno.***

Department of Nevada State University.

J. E. STUBBS, D. D., LL. D., *Director.*

There have been no material changes in the policy or the lines of work at the Nevada Station other than a readjustment of duties whereby a number of the staff are relieved of a portion of the teaching. The consulting chemist, N. E. Wilson, has resigned after fifteen years' service. W. B. Mack, of the veterinary college of Cornell University, has been given charge of a new department of bacteriology and veterinary science, and J. E. Church has been appointed cooperative observer in climatology and meteorology. As heretofore, the main lines of work have been agronomy, animal husbandry, and horticulture, as modified by the peculiar climatic and economic conditions of the region. Irrigation is essential to agriculture in most of the State and forms the basis of all the work. The irrigation investigations have been in cooperation with this Office, supplemented by a State appropriation, and include measurement of the water used on the station farm and studies of the water requirements of various cereals, sugar beets, alfalfa, and miscellaneous crops.

The growing of forage crops, particularly alfalfa, has received attention, especially as regards drought resistance in dry framing. A comparison has been made of alfalfa grown in the usual way and with oats, rye, and barley as nurse crops.

The work in animal husbandry has consisted largely of studies of the value of alfalfa for pasture, soiling, and hay in the production of beef, mutton, and pork. A herd of Holstein cattle is being built up, and an attempt is being made to improve the mutton quality of the flock of sheep by introducing Dorset blood.

The horticultural work is being developed with regard to the adaptability and cultural management of fruits and vegetables suitable to the conditions. The station has now, besides its orchard, an arboretum for the testing and growing of ornamental trees, and a botanic garden. Studies of range conditions and of the digestibility of range forage plants and native grasses, and also of the poisonous properties and principles of range plants, have been continued.

The work of the chemist on soils and waters of the State has been practically completed.

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During the year a meteorological observatory was erected on the summit of Mount Rose, 10,800 feet high and overlooking the Truckee Valley, in which the station is located. The equipment and maintenance of the observatory have been accomplished through the cooperation of the Nevada Academy of Sciences, the Weather Bureau, the university, and the station. It is believed that observations taken from this point will be of decided value in frost predictions and related problems.

No farmers' institutes were carried on during the year. It has been found difficult to arouse interest in such meetings, probably because of the recent rapid development of mining, although the rapid growth of mining towns and consequent increase of population should increase the demand for home-grown products and in this way eventually benefit agriculture.

Preliminary work in agriculture and horticulture is now under way at the substation recently established in the southern part of the State.

In order to provide elementary instruction in agriculture the university is considering the establishment of a high school course in that subject.

Bulletin 59, An account of some features of the climate of Reno, was the only publication of this station received during the year.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Farm products	940.76
Miscellaneous, including balance from previous year	793.06
Total	21,733.82

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

Considerable progress was made at this station during the year in reorganizing the work on a more efficient basis, and several promising lines of work under the increased funds made available by the Adams Act have been planned. The agricultural interests of Nevada are very small as compared with those of many other States, and therefore interest in agricultural education and research is comparatively limited. The absence of great pressure for practical results in experimental work resulting from this state of affairs leaves the station peculiarly free to take up and pursue unhampered some of the more advanced lines of agricultural research contemplated by the Adams Act.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

W. D. Gibbs, M. S., *Director.*

The New Hampshire Station has added a department of botany, under the direction of the former assistant botanist. The horticulturist has resigned to become State forester of Massachusetts, but it is planned to continue his variety work and studies in the breeding of vegetables. Some attention will also be given, in part by cooperative experiments, to practical orcharding. The agriculturist is endeavoring to devise and introduce means for reducing expenditures of New Hampshire farmers for feedstuffs and fertilizers. Among the lines of work under way are cooperative field tests with varieties of corn, culture trials with oats, and feeding experiments with dairy cattle, in which grain is largely replaced by home-grown feeds. A comprehensive series of experiments in sheep raising has been begun. A method of fencing by inclosing a portion of the pasture by a high and close-mesh wire, thus forming a small paddock, into which the sheep are driven at night, while the remainder of the field is protected by lower and more open fencing, is believed to present a practical means of preventing injuries from dogs. Poultry experiments are also receiving attention.

A study of different kinds of milk pails, as affecting the bacterial content of milk, has been completed, and a score card has been devised as a guide for the purchase of milk by creameries, on the basis of aroma, acidity, and cleanliness, as well as fat content. An effort is being made to establish associations to test milk production in private herds and to demonstrate the importance of weeding out inferior cows. The entomologist has continued his studies on the brown-tail and gipsy moths, and has commenced studies upon the codling moth and shade-tree pests. The "better farming special" railroad train, which covered nearly every section in the State and was inspected by over 15,000 people, was manned largely by the station staff. Considerable attention has also been given to farmers' institutes.

The publications of this station received during the year were as follows: Bulletins 120, The dairy industry in New Hampshire; 121, The gipsy moth in New Hampshire; 122, The brown-tail moth in New Hampshire; 123, The inspection of fertilizers in 1905; 124, The inspection of feeding stuffs in 1905; 125, Vegetable novelties; and 126, The care of composite milk samples.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	1,635.88
Total	21,635.88

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The number of agricultural students in the college is increasing. Additional funds are urgently needed for its inspection and demonstration work, in order that the station officers charged with experimental work may be able to devote themselves to it more thoroughly and continuously. With the increase in the number of students and the growth of the experimental work there should be a clearer differentiation of the work of the college and station. The station needs a stronger organization and should have a director who can devote himself wholly to the promotion of its interests.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

E. B. Voorhees, D. Sc., *Director.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

E. B. Voorhees, D. Sc., *Director.*

The work of the New Jersey stations has been in development of the lines inaugurated in previous years. The addition of about 45 acres to the station farm has provided facilities for extending especially the work in soil chemistry and bacteriology by affording opportunity for plat experiments in addition to the laboratory and greenhouse studies. This work is developing along the line of a study of bacteria in relation to the fertilizer requirements and fertility of soils, especially their nitrogen economy, the phase at present under investigation being the function of lime in the control of bacteria. In this connection the elaborate pot experiments have been still further developed.

About 4 acres are also devoted to plant breeding. Some results have been obtained which are of both scientific and practical interest, including the production of valuable varieties of sweet corn, tomatoes, eggplants, Lima beans, and squashes.

In the horticultural department an experiment has been planned to cover all of the problems connected with the growing, handling,

and selling of peaches. Trees have already been set out on 5 acres of typical peach land in Hunterdon County, and a similar area is to be utilized in the southern part of the State. Considerable data has also been obtained on the apple and asparagus industries. Experimental work with small fruits and vegetables has been continued, particularly as to the effect of fertilizers and the use of irrigation to supplement rainfall. The resignation of G. F. Warren as horticulturist, to accept a position at the Cornell Station, has been followed by the appointment of M. A. Blake, of the Massachusetts Station.

Experiments in cooperation with farmers are being continued on a larger scale at Hammerton to study the question of forage plants adapted to that region, as well as of methods of soil improvement. The results of three seasons are most encouraging as showing the adaptability of the poor sandy soils of that region when rightly treated for the growth of a wide variety of forage plants, and the possibilities of rapid improvement by the proper use of legumes. Tests of the adaptability of alfalfa to the State are being made in cooperation with this Department.

The relative value of alfalfa as a source of protein, the value of a number of new concentrates, and studies of the carbohydrates of feeding stuffs, particularly of beet pulp, have also received attention.

The department of biology is pursuing studies concerning oyster propagation begun some time ago with gratifying results, although the funds for this purpose are inadequate and further State aid is desired. At the last session of the legislature an appropriation of $350,000 was made for the eradication of mosquitoes, and an aggressive campaign has been begun.

The publications of these stations received during the past fiscal year were as follows: Bulletins 186, Late fall spraying for the San José or pernicious scale; 187 and 188, Analyses and valuations of commercial fertilizers; 189, Dried beet pulp as a substitute for corn silage; dried beet pulp versus dried molasses beet pulp; dried molasses beet pulp versus hominy meal; 190, Alfalfa; 191, Seed distribution of 1904 and for 1905; 192, Breeding sweet corn—cooperative tests; 193, Concentrated feeding stuffs; 194, Spraying; A report on mosquitoes; and the Annual Reports for 1904 and 1905.

The income of the stations during the past fiscal year was as follows:

State Station: State appropriation (fiscal year ended October 31, 1906)	$31,300
College Station:	
United States appropriation, Hatch Act	15,000
United States appropriation, Adams Act	5,000
Total	51,300

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The work of these stations has made substantial growth during the year in scientific efficiency and broad practical usefulness, exemplifying in an unusual degree the harmonious development of these two essential elements of successful research in the interest of agriculture.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, *Agricultural College.*

Department of New Mexico College of Agriculture and Mechanic Arts.

LUTHER FOSTER, M. S. A., *Director.*

The work of the New Mexico Station has been largely in continuation of that of previous years. The extensive investigations on the forage value of cacti and the nutritive value of the fruit have again been a prominent feature. The results of feeding and digestion experiments with cattle indicate that certain varieties are of considerable value as roughage, and the fruit is found to yield jellies and other fruit products of excellent flavor. The grape crown-gall investigation and the phenological orchard fruit observations have likewise been continued.

The cooperative irrigation investigations with this Office have been completed and the station is carrying on the work independently. Thus far it has included tests of the cost of irrigating a number of farm and garden crops, river water versus well water, temperature, evaporation, and the efficiency of pumping plants in the Rio Grande. A pumping plant with a capacity of about 1,500 gallons per minute has been installed. It is planned to use the funds from the Adams Act largely for the employment of an irrigation engineer and the extension of the irrigation work.

Horticultural work on the land formerly used for his purpose has been largely given up and an effort is being made to develop a tract recently purchased. The soil is sandy and wind swept, causing much difficulty in preparing the land for irrigation and cultivation, and the depredations of mice and rabbits have also made difficult the securing of a good stand of plants. Nevertheless peach orchards and a vineyard have been planted for the special purpose of testing additional varieties and comparing different methods of training, management, and marketing. Experiments have also been started with Irish and sweet potatoes, tomatoes, onions, peanuts, celery, and melons, and a new plantation has been opened for forest and ornamental trees.

The publications of this station received during the year were Bulletins 54, Soil moisture investigations for the season of 1904, and 55, Tuberculosis in cattle and tuberculin tests of the station herd; and the Annual Reports for 1903 and 1904.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Farm products	1,971.07
Miscellaneous	1,050.00
Total	23,021.07

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The vice-director has recently been appointed superintendent of farmers' institutes and cooperative experiments, and will spend the greater part of the year in traveling over the Territory organizing this work. Agricultural organizations of Spanish-speaking families have been formed at Las Cruces and Mesilla Park, which have proved very successful. The station is also an active participant in the newly organized Territorial Horse Breeders' Association. The number of agricultural students in the college is growing, and although the institution is still handicapped by inadequate funds, appreciation of its work seems to be increasing.

NEW YORK.

New York Agricultural Experiment Station, *Geneva*.

W. H. JORDAN, D. Sc., *Director*.

Progress in investigation at the New York State Station has been mainly in the direction of extension and development of well-established lines pursued for a number of years. During the year an elaborate monograph on apples of New York in two volumes was completed, and some monographic work on other fruits is contemplated. Among other subjects engaging the attention of the horticulturist are dwarf apples, orchard tillage and fertilization, spraying, breeding of small fruits, Mendel's law as applied to tomatoes, and miscellaneous greenhouse experiments. An investigation which promises to give especially interesting results is a comparison of tillage and sod for orchards.

The efficiency of soil inoculation for legumes, especially alfalfa, and the best methods of culture of the latter crop are being tested in different parts of the State. Tests of the quality of commercial cultures for inoculating legumes were completed during the year. The cause and prevention of undesirable flavors and of rusty spot

in cheese have been investigated, and studies of the normal and abnormal bacterial flora of cheese have been continued. An attempt is being made to work out a uniform classification of bacteria, using as a starting point the bacteria of the soft rot of vegetables.

Experiments on the use of concentrated by-products in poultry feeding and on breeding poultry are being continued and are becoming each year more valuable as a reliable basis for definite conclusions on many scientific and practical points. A study of the organic phosphorous compounds of feeding stuffs has yielded many important results bearing upon the metabolism, laxative, and other physiological functions of these compounds in the case of milch cows.

Conclusive results were secured by the entomologists from tests of applications of sulphur washes for controlling the San José scale, and under certain conditions this practice is recommended. The life history and systematic relationships of apple and pear mites have been satisfactorily established.

Other lines of work have included field and forcing-house work upon some of the problems of plant nutrition and soil fertility, the feeding of steers and heifers upon home-grown or purchased protein, a test of a milking machine, an investigation of the action of acids on casein in forming insoluble compounds, chemical studies of kumys and of carbonated milk, investigations of alfalfa diseases and alfalfa dodder, continuation of the work in spraying potatoes and in studying the influence of seed potatoes on the yield, test of oils for scale treatment, and studies of poplar weevil, apple maggot, and root maggots.

The demonstration experiments have continued to increase. Spraying and fertilizer trials, tests of the economy of dwarf orchards, and other questions of orchard management have been carried on. The station has cooperated with the Bureau of Plant Industry in the cold storage of fruit, and with the Bureau of Entomology on wheat insects.

A number of changes occurred during the year in the personnel, notably the resignation of the associate chemist and the addition of assistants in horticulture, botany, entomology, and bacteriology. The plan agreed upon for the division of the Hatch funds between the two stations in New York was continued for the Adams fund, so that but one-tenth of that appropriation is available to this station.

The publications of this station received during the year were as follows: Bulletins 268, Inspection of feeding stuffs; 269, Winter injury to fruit trees (with popular edition); 270, The quality of commercial cultures for legumes (with popular edition); 271, The adaptability of concentrated by-products for poultry feeding; 272, Report of analyses of samples of fertilizers collected by the commissioner of agriculture during 1905; 273, Spraying for the San José

scale (with popular edition); 274, Director's report for 1905; 275, Apple districts of New York, with varieties for each; 276, Varieties of strawberries and cultural directions (with popular edition); 277, The Bang method of controlling tuberculosis, with an illustration of its application (with popular edition); 278, Varieties of raspberries and blackberries, with cultural directions (with popular edition); 279, Potato spraying experiments in 1905 (with popular edition); the Annual Report for 1903, part 2, vols. 1 and 2, the apples of New York; and the Annual Report for 1904.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$1,500.00
United States appropriation, Adams Act	500.00
State appropriation	79,500.90
Total	81,500.90

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this department and have been approved.

During the year the station's high standard of efficiency has been fully maintained. Through its excellent system of popular bulletins and demonstration enterprises, as well as through its close relations with the federated agricultural organizations of the State, its influence as a factor in improving agricultural methods and conditions continues to be more and more widely felt.

Cornell University Agricultural Experiment Station, *Ithaca.*

Department of New York State College of Agriculture at Cornell University.

L. H. Bailey, M. S., *Director.*

The year at the Cornell Station has been marked by development in all lines, additions to buildings and equipment, and enlargement of the working staff. With the completion of the new buildings, for which the last legislature appropriated $300,000, the college of agriculture and station will be adequately housed, and recent acquisitions of farm land provide much more suitable experimental fields than those heretofore available. T. L. Lyon, formerly of the Nebraska Station, has been added to the staff to give especial attention to studies on soil fertility, and H. J. Webber, in charge of the plant breeding investigations of the Bureau of Plant Industry, has been secured to take charge of the work in experimental plant biology. A plan of reorganization has been decided upon, under which the Federal funds are to be devoted exclusively to experimental work by a staff entirely relieved of other duties. The departments thus far organized under this plan are agronomy, chemistry, and entomology, the three cooperating for the present mainly in the study of questions bearing upon the improvement of timothy, including specific

methods for determining the fertilizer requirements of soils, examination of soil solutions under different soil conditions detrimental to crop production, and insects infesting timothy grass. Other lines are to be carried on as formerly, but provided for from State funds.

During the past year the work has proceeded as previously arranged, and has included a general study of root crops in relation to forage problems in the State, methods of culture of various pasture grasses and field crops, and breeding experiments with timothy and clover. Variety testing of alfalfa, Indian corn, and dwarf milo maize has been continued, and studies of the relation between the soluble plant food in the soil and plant growth have been undertaken. The studies of the effects of environment on the chemical composition of sugar beets have been brought to a close, and additional attention devoted to experiments to increase the sugar content of sweet corn by selection.

Experiments in meat production and animal breeding have followed the lines of previous years. Additional investigations in animal industry include tests of milking machines, studies of the economical production of sanitary milk and of market milk problems in cooperation with the Bureau of Animal Industry, the making of butter from whey, investigations of the early lamb industry, and various feeding and housing problems with poultry.

In horticulture attention has again been directed mainly to experiments in shading plants, the effect of acetylene light as a supplement of sunlight on their growth, ether forcing, and monographic studies of beans and peonies. Some attention has also been given to the propagation of the sour cherry, a study of oriental pears, and minor investigations with vegetables. An orchard survey of Niagara County is contemplated. Cooperative spraying experiments have been carried on for curculio and the grape-fruit worm, and studies are also reported on the rose chafer, cankerworm, and a number of insects attacking shade trees. The plant pathologist has begun a study of the "little peach" in cooperation with the Bureau of Plant Industry, and has investigated a number of leaf diseases, notably of the quince, pear, plum, alfalfa, tomato, and ginseng.

The extension work has been vigorously conducted and continues to embody some unique features. A rural schoolhouse has been erected recently at the college at a moderate cost, to serve as a model for duplication in the State. The reading courses for farmers and farmers' wives continue to be popular, and 1,782 teachers were registered as participants in the school-garden movement. Several hundred demonstration experiments were in progress in cooperation with farmers. An awakening of interest in the college of agriculture by the people of the State is shown by the establishment of seven grange

scholarships and the endowment of five scholarships by Dr. C. H. Roberts, of Ulster County.

The publications of this station received during the past fiscal year were as follows: Bulletins 226, The apple industry of Wayne County; 229, An apple-orchard survey of Orleans County; 230, Quality in potatoes; 231, Second report on the forcing of strawberries, notes on the forcing of tomatoes, cucumbers, and melons; 232, Experiments on the influence of fertilizers upon the yield of timothy hay when grown on Dunkirk clay loam in Tompkins County; 233, Two new shade-tree pests, saw-fly leaf miners on European elms and alders; 234, The bronze-birch borer; 235, Cooperative spraying experiments—I, experiments against the plum and the quince curculio—II, final demonstration of efficiency of a poison spray for the grape-root worm—III, making Bordeaux mixture with "new process" or prepared lime; 236, The blight canker of apple trees; 237, Alfalfa; 238, Buckwheat; and 239, Some diseases of beans; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$13,500.00
United States appropriation, Adams Act	4,500.00
State appropriation	[a] 10,000.00
Farm products	325.89
Total	28,325.89

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

With its radical changes in policy, the strengthening of its staff, and the increase in buildings and other facilities, the Cornell Station presents a marked increase in efficiency. The clear differentiation between research and extension work should tend toward the consistent development of both, and the station possesses an exceptional opportunity for leadership in problems confronting agricultural thought and progress.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

B. W. Kilgore, M. S., *Director.*

The North Carolina Station continues to do good work for the agriculture of the State. The close cooperation of the State department of agriculture has been of material assistance. In this way four State farms, in addition to that at the station, are available for experi-

[a] Estimated amount of State appropriation spent for experimental purposes.

mental work and afford excellent opportunities for the study of special problems in soils, farm management, and field and orchard crops in typical localities of the State.

At the station farm the work has proceeded as in previous years, being devoted largely to fertilizers, culture of forage crops, and soil improvement. The agriculturist retired at the close of the year and is now director of the Kansas Station.

The biologist is making a comprehensive study of the lettuce crop, especially as regards the means of dissemination, soil sterilization, and similar problems. A private plant at Newbern, in the lettuce district, has been placed at his disposal, and experiments are proceeding both out of doors and under glass. He is also studying a number of apple diseases which seem to be new, and is continuing demonstration and spraying trials and breeding work for resistance with watermelons, tobacco, and sweet potatoes. The chemist is prosecuting an inquiry into the nitrifying power of different soils for organic and ammoniacal nitrogen. For organic nitrogen, asparagin has been chosen as a body of known constitution.

In other departments the work is proceeding mainly on the lines of previous years. Special attention is being given to feeding and breeding work with poultry, in which there is a good deal of interest in the State. The dairyman has been testing several methods to control the garlic flavor in milk, studying the acid content as affected by silage, the period of lactation, etc., and is making an inspection of farm dairies. The veterinarian has worked almost wholly on Texas fever and has succeeded in eradicating it from 26 of the infected counties.

The publications of this station received during the year were as follows: Bulletins 190, The formation of nitrates in the soil; 191, Egg preservation; 192, Farm dairying; and 193, Spraying mixtures and machinery, when and how to spray; and the Annual Report for 1904.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	[a] 17,784.00
Farm products	372.35
Total	38,156.35

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

[a] Estimated amount of State appropriation for experimental purposes during the fiscal year ended December 1, 1906.

The North Carolina Station is making a strong impress upon the agriculture of the State, largely through its branch farms, and is also conducting some good investigations into fundamental problems. Its work is much appreciated and it is in a position to be of great value to the agricultural industries of the State.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*[a]

Department of North Dakota Agricultural College.

J. H. Worst, LL. D., *Director.*

The North Dakota Station has made material progress, although the extremely wet season interfered very considerably with the field and plat work. Good results were obtained from grasses and clovers, but most of the small cereals failed to mature. The necessity of drainage in the Red River Valley is becoming apparent, and the station has undertaken an investigation of the feasibility of tile drainage in cooperation with this Office. At the Dickinson and Edgeley substations conditions were more favorable and the plant-breeding work was successfully continued.

Among the investigations closed during the past year are studies of the rapid diagnosis of rabies by means of the lesions of Nelis and Van Gehuchten and Negri. Improvement of the wild plum by seed selection has resulted in the third generation in individuals bearing fruit over an inch in diameter and in a fair degree of fixity of type. Continuous growing of grain crops and flax has proved ineffective as a means of checking a rapid increase of wild oats and other weeds, while introducing a cultivated crop into the rotation once in four years has reduced the weeds materially, and grass crops for three or more years have eradicated them almost wholly.

Laboratory experiments have recently been inaugurated with "swamp fever" or anemia of horses. The chemist is taking up investigations of the wearing qualities of paints and paint materials, the bleaching of low-grade flours, and studies of formaldehyde. The study of soils will be resumed, particular attention being given to the rôle of humus. Feeding experiments are being conducted along the lines of previous years with steers and swine, and breeding experiments with swine, sheep, and poultry.

The station has continued its study of plant diseases, especially the wilt and rust of flax, and its plant-breeding work with wheat, flax, and potatoes. A number of demonstration farms have been established along the two principal railway systems of the State. The teaching of agriculture in the public schools has been encouraged and correspondence courses in agriculture have been instituted.

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[a] Freight and express address, *Fargo.*

A chemical laboratory, costing about $48,000, has been completed, which contains offices and laboratories for station and college work and provides much needed facilities. A greenhouse is to be erected for the botanist. A part of the funds from the Adams Act was used in the purchase of a complete miniature modern roller flour mill and a complete set of apparatus for baking tests. A comprehensive study of wheat and flour is being planned, to continue from eight to ten years and to cover all phases of the subject.

The publications of this station received during the past fiscal year were Bulletins 65, Experiments in clover growing, trials with alfalfa; 66, Water for domestic purposes in North Dakota; 67, Paints and paint products; and 68, Rust problems; Part I of the Annual Report for 1904; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation for substations	1,250.00
Farm products, including live stock	2,121.56
Miscellaneous	367.21
Total	23,738.77

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The inspection work of the station continues to increase and now occupies a large part of the time of a number of the staff. State aid is to be sought to carry on this routine work, and in view of the substantial character of the investigations now under way it is to be hoped that a more adequate financial support for the station will be forthcoming.

OHIO.

Ohio Agricultural Experiment Station, *Wooster*.

C. E. THORNE, M. S. A., *Director*.

The Ohio Station has been further developing its forestry work under a State appropriation providing for a department of forestry, and Edmund Secrest, of the Kansas College, has been appointed assistant in forestry. The department will consider especially problems relating to the management of the farmers' wood lot. Over 400 forestry plantations have been established over the State, mostly of catalpa and black locust, to meet the special demand for woods suitable for posts. The increased State appropriation has also made possible the establishment of a department of animal husbandry, and an experiment in feeding lambs has been carried on in cooperation with an extensive feeder with very satisfactory results.

The field work has gone on as in previous years, and has included comprehensive studies of the use of fertilizers, varieties, rotations, and similar questions. The corn-breeding work for yield and protein content is assuming considerable importance. Variations in yield at the rate of from 55 to 104 bushels an acre have been found in individual ears. The effect of high protein content on the growth and the yield is very striking almost from the start, the high protein corn increasing the crop about 8 bushels an acre. Selection work is also being carried on with wheat and oats from individual plants for yield and for protein content, and also for stiffness of straw and time of seeding. Cutting oats in the spring was found to have a marked effect in preventing lodging. Considerable work has been done on alfalfa, especially on the time of seeding.

The horticulturist is studying mulching *v.* cultivation of orchards, and the treatment of pear blight. He is making cooperative spraying experiments, and in the greenhouse is forcing muskmelons, tomatoes, and other crops. A treatment of greenhouse soil by mulching with barnyard manure has given as good results as composting, and there has been no disease so long as it has been kept moist.

The entomologist has been conducting spraying trials with the grape-berry moth and the codling moth, and has made a thorough study of the life history of the Hessian fly. In cooperation with the park commissions of Cleveland and other cities studies have been made of insects affecting shade trees.

The breeding and crossing of wheat, oats, corn, tobacco, and other crops have been carried on by the botanist. The rhizoctonia in greenhouses, especially on lettuce and tobacco beds, has also received attention, and a method for its control by sterilizing the beds with formalin has been devised, which is believed as effective as steam and less expensive. Special attention is being given to diseases of peas and beans and a voluntary seed inspection is being made.

The publications of this station received during the year were Bulletins 152, 163, Meteorological summary—press bulletins—index; 162, Plums for home and market; 164, Winter practice in economic zoology; 165, Experiments with winter wheat; 166, The newer strawberries; 167, Fertility studies on Wooster soil; 168, Fertility studies on Strongsville soil; 169, Spraying for the San José scale; 170, Peaches for home and market; and 172, Experiments with fertilizers on tobacco; besides 13 circulars and the Annual Reports for 1904 and 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation, including balance from previous year	80,010.86
Fees	140.75
Farm products, including balance from previous year	14,433.18
Miscellaneous	1,713.93
Total	116,298.72

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

During the year a special State appropriation, aggregating $55,700, was obtained, some of the items being $6,000 for the publication of bulletins, $5,000 for forestry, $6,000 for animal husbandry, $12,000 for entomology, botany, horticulture, and chemistry, and $7,000 for substations. The readiness with which this appropriation was granted indicates the support which the station has gained for its work. Its demonstration and extension activities, including extensive cooperation with farmers in culture and varieties of field crops, spraying, forestry, and other lines, bring its work into close touch with the people over the entire State.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College.

W. L. English, B. S., *Director.*

The principal work at the Oklahoma Station during the past year has been the preparation for experimental use of the new farm of 640 acres, the erection of a new agricultural building, and the rearrangement of other buildings. (Pl. IV.) The new farm contains almost all the different varieties of soil found in the State, including both creek bottom and upland. The farm as a whole will be carried on largely in a commercial way, in an effort to pay running expenses, but the station has been permitted to select for its use tracts of various kinds. Special attention will be given to studies of the methods of treatment of thin upland soils. An agronomist has been engaged, and experiments have been begun with corn, cotton, alfalfa, oats, wheat, Kafir corn, and castor beans. Pasture experiments are being made with hogs and dairy cattle.

Morrill Hall, the new agricultural building, is a substantial structure of stone and brick, costing with equipment about $75,000. In addition to administrative offices and quarters for the agricultural

FIG. 1.—NEW AGRICULTURAL BUILDING, OKLAHOMA STATION.

FIG. 2.—BARN AND FEED LOTS, OKLAHOMA STATION.

department of the college, the office and laboratory work of the station will be concentrated in this building.

During the year Director Fields announced his intention of resigning, and in consequence an effort was made to prepare for publication accumulated results of previous years, rather than to inaugurate new work. W. L. English, a graduate of the college, and recently assistant in animal industry, was elected to succeed him at the close of the fiscal year.

Despite a feeling of uncertainty as to the status and policy of the institution upon the establishment of a State government, interest in the college and station has been steadily increasing. The bulletin edition is now 25,000 copies and the correspondence is unusually heavy. The college is leading an effort to consolidate rural schools and to introduce elementary agriculture. Normal courses in agriculture are being offered to prepare teachers for this work. All the courses in agriculture have proved very popular and there is widespread interest in the Territory in agricultural education in general.

The following publications have been received from this station during the year: Bulletins 65, Wheat growing; 66, The water supply; 67, Miscellaneous water analyses; 68, Soil inoculation—tubercle-forming bacteria of legumes (with popular edition); 69, Small fruits; and 70, Hardy Bermuda grass; the Annual Report for 1905, which is a summary by the director of the work and expenditures of the station during the year, to which are added abstracts of the press bulletins issued; and Circular 5, on the use of the artificial impregnator in horse breeding.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	2,500.00
Miscellaneous	2,425.27
Total	24,925.27

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Oklahoma Station now has an equipment which should enable it to develop and strengthen its work materially. Every effort should be made to conduct thorough and substantial experiments and investigations for the benefit of the rapidly expanding agriculture of the new State. To do this it will be necessary to establish and maintain a consistent policy of management and to employ thoroughly trained experts in the varied lines of agricultural research.

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OREGON.

Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College.

James Withycombe, M. Agr., *Director.*

The Oregon Station has continued its work upon the advantage and importance of crop rotations, which increase and conserve soil fertility, in contrast to the exhaustive system of summer fallowing so widely practiced under the present system of grain farming. Pot tests have been made to study the effect of the bare fallow and different rotations on soil fertility, especially as regards the nitrogen content, and experiments with soiling crops and various pasture and other forage plants have been carried on with a view to increasing the home growing of feeds and thereby encouraging dairying and animal production.

About ninety varieties of vetch have been tested, of which some have shown marked possibilities as forage crops. Grown with oats in rotation with clover, corn, and wheat, vetch has proved exceptionally useful, and a mixture of vetch and rye has given good yields as an early soiling crop. Breeding experiments to increase the protein content have produced individual plants containing 25.52 per cent of protein in the dry material. Considerable progress has been made in determining the feeding value of steamed and unsteamed vetch silage and corn silage, in the hope that dairymen might be able to substitute vetch in part for the expensive concentrated feeds now purchased. A comparison of vetch-seed meal with linseed meal did not give wholly satisfactory results.

The investigation of hop drying, inaugurated last year, has been continued. Drying at low temperatures has again proved very efficient as a means of conserving the lupulin.

Results of experiments in canning fruits and vegetables by a method of intermittent pasteurization devised by the bacteriologist have been published. Tomatoes, green beans, wax beans, cauliflower, asparagus, cherries, and cider treated in this way were found to keep perfectly and ranked as the highest grade of canned goods, but the method proved less satisfactory for beans, peas, and corn. The bacteriologist has also given further study to the retting of flax by pure cultures of organisms.

Cooperative work of various kinds has increased to a marked extent throughout the State. Alfalfa is being widely tested in this way, the station sending inoculated alfalfa soil last year to about 250 farmers. Spraying experiments for the apple scab have been carried on with local growers and are to be undertaken for the potato scab. The canning of pineapples and the utilization of the waste

products for sirup, wine, and vinegar is being investigated jointly with a resident of Hawaii. Other lines of cooperative work include studies of the value of various cover crops for the Rogue River Valley, the adaptability of various sections of Oregon to cranberry culture, irrigation investigations with this Office, and the testing of disease-resistant powers of varieties of potatoes.

The department of horticulture has been revived by the appointment of C. I. Lewis, who is expected to give his time exclusively to station work. The programme for the year includes variety tests, storage experiments with apples, a study of methods of handling apples at the time of harvesting, and of the effects of wiping and polishing, plant-breeding experiments with cherries and grains, pollination experiments, and experiments with methods of practical orcharding.

Bulletins 87, Canning fruit and vegetables, preserving fruit juices, and 88, San José scale, were received from this station during the fiscal year.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Balance from previous year	285.63
Miscellaneous, including farm crops	2,300.79
Total	22,586.42

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Oregon Station is doing valuable work along several lines, and its cooperative experiments with the farmers of the State have proved of decided benefit in disseminating results of station investigations, the introduction of new and valuable crops, and the study of local problems. The station is handicapped, however, by several pressing needs. Farm buildings are urgently required, as well as better library facilities, and in some of the departments additional assistance. These obstacles must be overcome if the station is to attain its highest usefulness.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

Department of the Pennsylvania State College.

H. P. Armsby, Ph. D, LL. D., *Director.*

No important changes in lines of work have been made at the Pennsylvania Station during the past year, although radical plans of reorganization have been formulated. An institute of animal nutrition is to be established as a special research department of the

college, to include the respiration calorimeter and allied nutrition investigations hitherto carried on by the station, with which it will be affiliated, although coordinate in rank. H. P. Armsby, who has been director of the station since 1888, will be in charge of the institute, and T. F. Hunt, of Cornell University and Station will succeed to the directorship of the station and will also act as dean of the college of agriculture.

During the year the respiration calorimeter and the methods followed in experiments with it have been perfected and simplified in many details. Investigations bearing on the general question of the nutritive value of foods as affected by age and individuality have been undertaken, and results of a series of experiments made in cooperation with the Bureau of Animal Industry to determine the relative value of certain feeding stuffs for maintenance and fattening have been published. Other lines of work in animal husbandry to be completed are comparisons of distillers' grains versus cottonseed meal as a source of protein for cows, indoor versus outdoor feeding for fattening steers, experiments to determine a practical succession of soiling crops for milch cows, and the feeding value of alfalfa meal versus wheat bran. The poultry plant has been improved and enlarged and experiments have been begun to determine the cost of meat production in the Asiatic, Mediterranean, and American breeds.

In response to an offer of the station to supply the necessary fertilizers and directions for cooperative soil tests in the various counties, more than 250 requests were received from which applicants in each of 38 counties were selected. Attempts to grow alfalfa on the limestone soils of the State have given results which are considered very encouraging.

A State appropriation has been used to extend the observations and experiments in Lancaster County on the growing and curing of Sumatra tobacco under shelter. While the results of the three years' work are not regarded as conclusive, this type seems well adapted to the lighter soils of the region. A beginning has been made in a study of the influence of seed selection on the type and form of Sumatra leaf and of the prevention of burn by the use of artificial heat and ventilation during the critical periods of curing.

The inspection duties and routine analytical work continue to be very heavy and consume a large share of the time of the chemical division. Analyses of feeding stuffs are now made by the State department of agriculture, but the station has recently undertaken for the millers of the State analyses of goods for which a State law requires a guaranty of composition. The general correspondence of the station has shown a decided increase, and the correspondence courses conducted by the college now have enrolled about 4,000 names.

The publications of this station received during the year were as follows: Bulletins 71, Relative values of feeding stuffs; 72, Experiments in growing Sumatra tobacco under shelter tent, 1903; 73, Distillers' dried grains *v.* cotton-seed meal as a source of protein; 74, Methods of steer feeding; 75, Forage and soiling experiments, 1904; 76, Variety tests of wheat, oats, and potatoes; and 77, Small fruits in 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	1,835.05
Fees	13,049.55
Farm products	3,106.55
Miscellaneous	893.93
Total	38,885.08

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Pennsylvania Station has been able to maintain a high grade of efficiency, although laboring under the disadvantage of prolonged delay in putting into effect certain contemplated plans of reorganization.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

D. W. May, M. Agr., *Special Agent in Charge.*

The work of the Porto Rico Station has been devoted chiefly to agricultural and horticultural crops, their insect and fungus pests, and various lines of animal husbandry, with such attention as has been possible to problems relative to the use of fertilizers, soils, drainage, farm machinery, forestry, etc. Two changes have occurred in the staff, the appointment of W. V. Tower, of the Massachusetts Agricultural College, to the vacancy in entomology and plant pathology, and the resignation of H. C. Henricksen as horticulturist, followed by the appointment of M. J. Iorns, of Cornell University, to this position.

During the year the tobacco industry has greatly developed in the island, and the acreage and quality of the crop have been much increased. The station has introduced the White Burley type from Kentucky, which has been found to grow vigorously and produce heavy yields. The improvement of Porto Rican coffee, both by fertilization and the introduction of foreign types for which there is

a better demand in the United States, has been continued at the substation, together with investigations of the insect pests and diseases and some very promising studies of malting. A collection of sugar canes has been obtained from the Louisiana Station, some of which have proved well adapted to Porto Rican conditions, and have been distributed to planters for further tests. A scheme for testing the fertilizer requirements of sugar cane has been taken up on a number of plantations, and on several a small portion of the estate is now regularly set aside for experimental work. The station is encouraging the most extensive cultivation of rice and a number of forage crops. Among these, cowpeas are most successful and are recommended for all localities. Alfalfa has given good results on well-drained land, and is regarded as valuable under certain conditions. Tests of an Indian variety of pigeon peas and of the sword bean indicate that these are also worthy of more extensive cultivation.

In cooperation with the insular government experiments in fiber production have been inaugurated. Of various fibers sisal promises the greatest returns. A small insular appropriation has made possible the importation of a number of thousands of plants, and it is hoped to put the industry on a commercial basis. Efforts are also being made to stimulate the growing of the palm fiber used in the manufacture of Panama hats now made on the island from imported material.

A beginning has been made in the reforestation of the uplands. It has been found that this can not be done directly, but must be preceded by the growth of trees of little economic value to serve as shade. Great interest is developing in the work in tile drainage, which has hitherto been unknown, although many acres of land could be profitably reclaimed in this way. The station is temporarily manufacturing tiles as a means of encouraging the practice. Experiments are also being carried out in cement construction, especially for fence posts, as wooden posts are of but short duration because of the ravages of insects.

The live stock of Porto Rico is greatly in need of improvement, as but little pure-bred stock has ever been introduced. Results with cattle, pigs, and poultry thus far indicate that successful acclimation is possible if certain precautions are observed, and good success is attending the efforts of the station in this direction.

The experimental work in horticulture continues to occupy an important place. The station orchard now comprises 25 acres with over 100 species of fruit trees. Plantings of citrus trees, cacao, mangoes, and other economic plants have been established, and experiments on their cultivation and fertilizer requirements are in progress. Special attention is being given to pineapple culture and shipment. A number of trial shipments have been made to New York

and to Washington, D. C., the principal object being to test the shipping qualities and also the methods of packing. Experiments in vegetable growing have demonstrated that with fresh seed and liberal use of fertilizers and proper cultural methods it is possible to grow for local consumption nearly every kind of vegetable produced in temperate climates, and that shipment is feasible when market conditions will warrant.

The entomologist and plant pathologist is devoting particular attention to the pests of citrus fruits. Experiments are being carried on to determine the value of various insecticides and fungicides and the strengths required for the destruction of the pests without injury to the trees. In a similar way attention is being given as opportunity offers to the pests of other crops, such as coffee, sugar cane, cacao, etc.

During the year the station has issued Bulletin 6, The yautias, or taniers, of Porto Rico, and a Spanish edition of Bulletin 5 on tobacco investigations.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,164.52
Total	16,164.52

The rapid development of agriculture in Porto Rico and especially the influx of planters make the discovery and dissemination of results contributing to an enlightened agricultural practice of exceptional importance. The work of the station is fast becoming recognized as an important factor in this direction. A decided increase of interest in its work is being manifested, and its opportunities are restricted only by the limited funds at its disposal.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, ***Kingston.***

Department of Rhode Island College of Agriculture and Mechanic Arts.

H. J. Wheeler, Ph. D., *Director.*

The Rhode Island Station continues to make problems in turkey raising a prominent feature of its work, especially with reference to determining the nature and method of transmission of the blackhead disease and the possibility of remedial treatment. The disease is now believed to be caused by a parasite, and breeding experiments are being continued to develop a strain of turkeys immune to it. The resignation of Dr. Cooper Curtice, who was formerly in charge of this work, has been followed by the appointment of Dr. L. J. Cole, of Harvard University, who is investigating the disease, and of J. W. Bolte, of the Utah Station, who is in charge of the poultry feeding.

The poultry equipment has been considerably increased by the construction of additional houses, yards, etc.

The field and laboratory investigations on the relations of lime and soda to plant growth have again been carried on in cooperation with the Bureau of Soils, together with tests of the relative efficiency of the paraffin wire-basket method, originated by the Bureau of Soils for determining soil deficiencies, as compared with the Wagner 8-inch pot and actual field tests. Many farmers of the State are also cooperating in soil studies.

Among other lines of work taken up are studies of the improvement of land by legumes grown with corn, variety tests of flint corn, rotation to produce grass and corn on worn-out land, mixtures of grasses and legumes earlier than timothy and redtop for convenience of cutting, the feeding power of different crops for phosphoric acid in different forms, and the relative residual effect from these forms. A quite extended investigation was made upon the turnip as a means of indicating the phosphorus deficiencies in soils, and attention has also been given to mixtures of grasses for polo and golf links, the use of phosphoric acid as a supplement to seaweed, and of fertilizers for basic and active manures.

Plant breeding has been carried on with sweet corn to increase the number of ears, with strawberries to retain the flavor of the wild fruit, and with beans to secure resistance to frost. A State appropriation to the college has resulted in the erection of a new horticultural building and greenhouses at a cost of $15,000, one wing of which is to be for the use of the station.

The publications of the station received during the year were as follows: Bulletins 105, Commercial feeding stuffs; 106, Concerning the agricultural value of sodium salts; 107, The influence of soil treatment in greenhouse culture; 108, Analyses of commercial fertilizers; 109, A comparison of results obtained by the method of cultures in paraffined wire pots with field results on the same soil; 110, Commercial fertilizers; and 111, Trial of varieties of potatoes; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Miscellaneous	586.33
Balance for previous year	3,216.91
Total	23,803.24

Reports of the receipts and expenditures for the United States fund have been rendered in accordance with the schedules prescribed by this Department and have been approved.

FIG. 1.—NEW RESIDENCE, OFFICE AND LIBRARY, AND OTHER BUILDINGS AT NORTH LOUISIANA STATION AT CALHOUN.

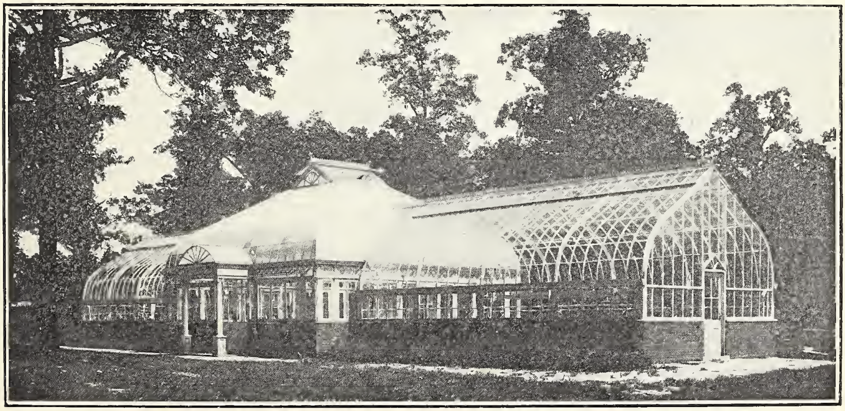

FIG. 2.—EXPERIMENTAL GREENHOUSE AT SOUTH CAROLINA STATION.

As a result of the passage of the Adams Act several tracts of land not hitherto utilized, have been prepared for experimental purposes. A number of additions have been made to the station staff, and it is hoped to differentiate the work of the college and station more completely. The extension work has been carried on by the college as in previous years, and has resulted in very great benefit to the agricultural interests of the State. The station is doing excellent work in both scientific and practical lines.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College*.[a]

Department of Clemson Agricultural College.

J. N. HARPER, B. S., M. Agr., *Director*.

The year at the South Carolina Station has been largely one of reorganization. The directorship has been established distinct from the presidency of the college, and the work of the station staff has been more clearly differentiated. The vacancy caused by the resignation of the botanist and bacteriologist has been filled by the appointment of H. D. House, of the Bureau of Plant Industry. Through the completion of the agricultural building much better quarters are now available for the station, although there is still a need of further equipment. A greenhouse, costing $6,000, has been erected for the use of several departments. (Pl. V, fig. 2.)

Considerable interest has been developed in the experiments on the production of starch from the sweet potato. Several hundred pounds of starch were manufactured with the station outfit, and samples submitted to a number of cotton mills and laundries elicited very favorable reports. The pulp remaining after the extraction of the starch also gives promise of making a very useful cattle food, and tests of its feeding value are now under way. Cotton breeding and improvement has been a leading subject of investigation to meet a demand from southern mills for a staple of higher grade and special character. The textile department of the college is cooperating in milling tests of several of the best cross-bred varieties.

The veterinarian has concluded a series of studies of scours in milk-fed calves, and recommends treatment with formaldehyde, one part to 4,000 parts of milk, as very efficacious. The horticulturist is making a special study of the seedling apples of the State, most of which are unknown beyond the locality in which they originated. Cultural and varietal tests of fruits and vegetables have been continued as heretofore. Soil maintenance and improvement, as related to the

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[a] Freight address, *Calhoun*.

growing of corn, wheat, oats, cowpeas, sorghum, alfalfa, and velvet beans, have received attention from the agriculturists, who have also instituted cooperative experiments with fertilizers and systems of rotation in different parts of the State. There has also been cooperation of the stations with the Bureau of Plant Industry in an investigation of the causes and treatment of the rice blast, and in the growing of vetches and other legumes and grasses; with the Bureau of Chemistry, in an attempt to increase the sugar content of sweet corn; and with the Bureau of Animal Industry in the eradication of Texas fever. The college geologist, assisted by the director, agriculturist, and botanist, is planning a plant and soil survey of the State with special reference to the geological formations. It is believed that such studies will be of service in the settlement of some fundamental soil problems.

The publications of this station received during the year were as follows: Bulletins 95, The milk scales, the milk sheet, and the Babcock test for the farmers of South Carolina; 109, Notes on varieties of apples; 114, A wasting disease of young cattle (verminous gastritis); 115, Analyses of commercial fertilizers; 116, Methods of spraying cucumbers and melons; 117, A comparison of wheat bran and cottonseed meal for milk production; and 120, Cotton experiments.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	2,635.53
Farm products	1,526.05
Miscellaneous, including balance from previous year	1,211.15
Total	25,372.73

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The coast-land substation at Charleston has continued its diversification trials and recommends the more extensive growing of forage crops. More than 11,000 farmers have been reached by the farmers' institutes, which have been participated in by eleven members of the station staff. The college has more applicants for admission than can be accommodated, and the number enrolled in agricultural courses is increasing. The general outlook for both the college and station is very promising, and it is to be hoped that plans under way can be carried out.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, ***Brookings.***

Department of South Dakota Agricultural College.

J. W. Wilson, M. S. A., *Director.*

Plant breeding, animal breeding, and feeding problems have continued to be the dominant interests at the South Dakota Station. Tests of about forty varieties of durum wheat as to their usefulness for bread making and macaroni have showed great variations and have resulted in the retention of several of the more promising types. It has been established in these investigations that the durum wheats are especially adapted to arid localities unsuitable for the ordinary sorts. Selection experiments with grasses indicate that the slender wheat grass (*Agropyron tenerum*) and the western wheat grass (*A. spicatum*) are of considerable merit. Encouraging progress has been made in the introduction of rust-resistant strains of alfalfa, millet, sorghum, clover, and other forage crops, and seed of some of the more promising sorts has been distributed at a nominal price.

Cattle feeding has been conducted mainly to determine the value of emmer. This has proved well-adapted to South Dakota conditions and has been found to be a promising substitute for corn in the production of baby beef. The value of various proprietary stock foods is being tested with pigs, and digestion experiments with sheep are being undertaken with the principal forage crops and grains of the State. In animal breeding reciprocal crosses of Yorkshire and Poland Chinas are being made, together with attempts to improve the quality of range cattle and both the mutton and wool types of sheep.

Rotation experiments are being carried on as formerly, and there is considerable study of plant diseases. Some very marked physiological results have followed the injection of chemicals into trees for the control of diseases, but as yet no pathological benefits have been noted. Breeding experiments with native wild species of fruits and importations from northern Europe and Asia have been continued on an extensive scale. A hardy raspberry of good quality has been developed, and the possibility of securing graft hybrids is being studied. Much of the work with grains and fruits has been carried on at the Highmore substation.

A test of dips for the prevention of sheep scab is proceeding, and studies of lumpy jaw are contemplated. A building for the use of the veterinarian is to be erected.

The publications of this station received during the year were Bulletins 92, Marconi wheat; 93, Plums in South Dakota; 94, Alfalfa and red clover; 95, The treatment of nail pricks of the horse's foot; 96, Forage plants and cereals at Highmore substation, 1904–5; and 97, Spelt and millet for the production of baby beef; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	1,000.00
Miscellaneous	2,658.11
Total	23,658.11

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The work of the South Dakota Station is on a very satisfactory basis and is much appreciated by the farmers of the State. An attempt is being made to take up lines of work in a scientific way, and definite problems are being attacked with less apprehension of failure to get immediate returns. In consequence some fundamental results are being obtained.

TENNESSEE.

Tennessee Agricultural Experiment Station, *Knoxville*.

Department of the University of Tennessee.

H. A. MORGAN, B. S. A., *Director*.

An active and aggressive attitude is characterizing the Tennessee Station, and good progress is being made in developing its work and strengthening it in the State. An investigation of importance recently begun is on the failure of clover. The botanist has traced the cause to a disease attacking both the stem and root, and occurring also on alfalfa, the Medicagoes and Lespedeza. It may be transmitted through the seed to some extent by soil inoculation and has also been carried by insects. At present it is widely distributed over Tennessee and to some extent in Kentucky and West Virginia.

In entomology the main lines of work are the life history of the cattle tick and peach borer. Some studies are also being made of stingless bees.

The horticulturist has under way a study of methods of pruning grapes. Results from a season's work with several varieties indicate the greatest benefit from long-arm pruning. He is also giving attention to the spraying of peaches.

A number of new lines were begun in agronomy, namely, rotation trials with and without legumes, soil and crop studies in connection with the use of different kinds of phosphates and lime, and variety tests of cereals, legumes, and forage crops. A study of the retentive power of different typical soils of the State, the formation of humus, and the means of maintaing the humus supply is also under way, together with a determination of factors upon which the retentive power depends.

In animal industry some studies have been made upon leucocytes in milk and the relation of the health of the animal to the number of leucocytes. Feeding experiments in connection with the dairy herd are under way, and there is some work with poultry.

During the year an effort was made to inaugurate cooperative experiments with farmers on some of the distinct soil types of the State. The results thus far secured have been very encouraging. Farmers' institutes have been participated in to about the usual extent, in cooperation with the State department of agriculture.

The passage of the Adams Act provided considerable equipment for the station, chiefly in additions to the library and in scientific apparatus. The attitude of the university to the station continues to be liberal. An agricultural building for the use of both is one of the needs, which has been met by a recent State appropriation.

The publications received from this station during the year were: Bulletins Volume 18, No. 1, Texas fever cattle tick—pasture methods of eradication; and No. 2, Small fruits and grapes; and the Annual Report for 1904.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	1,005.00
Farm products	5,791.43
Live stock	1,542.87
Total	28,339.30

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Tennessee Station is doing important service along several lines, and is showing much energy in getting its results before the people of the State. There are indications of increasing appreciation of its work, and the general outlook is very favorable.

TEXAS.

Texas Agricultural Experiment Station, *College Station.*

Department of the State Agricultural and Mechanical College of Texas.

J. W. CARSON, B. S., *Acting Director.*

The work of the Texas Station has proceeded along the lines of previous years, although handicapped by the ill health of the director, who resigned his position at the close of the year. Feeding experiments with by-products of local production such as molasses, rough rice, and fermented cotton seed have been completed. Work in agronomy has been restricted mainly to cotton and corn, but cooperative experiments with sorghum, milo maize, and Kafir corn are under way in some arid sections of the State. Elaborate cotton experiments, chiefly in breeding, are being carried on through the cooperation of the cotton specialist with the Bureau of Plant Industry. There has also been cooperative work with farmers, including fertilizer trials, and a test of the yield of cucumbers for pickles at Palestine.

A department of entomology has been established, which has begun investigations on the sweet-potato borer, melon louse, citrus white fly, Morelos orange maggot, the cotton boll weevil, and the San José scale. The veterinarian continues to give special attention to the study of Texas fever. The horticultural work is largely pomological, emphasis being given to peach culture, variety tests, and fertilizer and culture trials. Breeding experiments are to be carried on with tomatoes and grapes, including a study of the geotropism of different species of the vine, and investigations of the value of native species as a resistant stock for *Vitus vinifera* varieties. Thus far *V. champini* has shown most promise. Figs and citrus fruits are being specially studied at Beeville, and plums, apples, and small fruits at Troupe, where substations are still maintained by the State.

A study has been made by the botanist of nitrogen assimilating bacteria, showing these to be of doubtful value. Seed tests indicate a need of seed inspection, as the State is being made a dumping ground for inferior stock. The feeding-stuffs inspection has been thoroughly established and nets the station some additional funds.

Bulletin 76, Experiments in steer feeding, was the only publication received from this station.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Farm products	965.00
Miscellaneous	2,573.31
Total	23,538.31

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The field work at the station is being brought together on a single large tract of land, on which it is hoped to erect suitable buildings. A plant house for the winter work of the botanist is also much needed. During the year the college and station work have been well differentiated. The number and grade of the agricultural students are increasing. The farm mechanics laboratory is being developed, and considerable machinery has been contributed to it by manufacturers.

UTAH.

Agricultural Experiment Station, *Logan.*

Department of the Agricultural College of Utah.

P. A. Yoder, Ph. D., *Director.*

The year at the Utah Station was marked by the appointment of a new director and numerous changes in the staff, although there has been no material departure from the previous policy and lines of work other than the concentration of activities upon a somewhat more restricted number of projects. Irrigation has continued to be the leading feature. Two small farms devoted exclusively to irrigation experiments have been carried on, one confined to a study of methods of irrigation in cooperation with this Office, and the other used for studies of the water requirements of different crops in cooperation with the Bureau of Plant Industry. Studies of the irrigation practice of the State and of winter irrigation are being made, and alkali reclamation work near Salt Lake was carried on in cooperation with the Bureau of Soils.

The dry farming experiments carried on in different parts of the State under State appropriation have yielded valuable results in showing the localities and conditions under which such farming is likely to be profitable and the methods which should be pursued to insure success. Some of the farms have been more successful than others, and for this reason several of those already established will probably be either abandoned or continued for a time merely as demonstration areas, while others will be developed as centers for more advanced investigation. Additional farms will be established for more fully determining the areas of the State best suited to this character of farming.

Studies of the codling moth, sugar-beet leaf hopper, grasshoppers, and various strawberry insects have been taken up by the entomologist. Spraying is now being more generally practiced in the State, to the great improvement of the quality of the fruit produced. The

means of dissemination and control of tomato blight are being investigated, and there have been studies of sugar-beet seed improvement and variety tests of alfalfa.

Feeding experiments have been largely directed to the utilization of available Utah feeds for horses, cattle, sheep, and swine. The poultry department is to be strengthened and made a more prominent feature, and a department of dairying has been established.

The horticultural work at the Brigham City substation has been given up, but continued as usual at St. George. A new substation has been established at Lehi, which has been used chiefly for variety tests of orchard crops. These substations have been maintained by State appropriations of $8,000 and $6,000, respectively, for two years.

The publications of this station received during the year were Bulletin 92, Poultry experiments, and circulars giving memoranda of plans for arid farm and irrigation investigations.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15, 000. 00
United States appropriation, Adams Act	5, 000. 00
State appropriation, including substations	21, 376. 84
Farm products, including substations	2, 853. 38
Miscellaneous, including balance from previous year	395. 00
Total	44, 625. 72

Reports of the receipts and expenditures of the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Utah Station has suffered from the lack of permanency in its personnel and the difficulty of securing and holding a sufficient force of experts to properly man its various departments. In view of this fact the policy of concentration on a limited number of the most important lines of work seems especially wise.

VERMONT.

Vermont Agricultural Experiment Station, ***Burlington.***

Department of University of Vermont and State Agricultural College.

J. L. Hills, Sc. D., *Director.*

With a view to expanding and developing the work in dairy husbandry at the Vermont Station, C. L. Beach, of the Connecticut Storrs Station, has recently been added to the staff as the head of this department. Experiments in horse breeding, using Morgan blood as a basis, have recently been inaugurated in cooperation with the Bureau of Animal Industry. The stud now consists of nine animals. A tract of 65 acres has been acquired and a breeding barn has been fitted up. Another recent investigation is that of etherization on

rhubarb, asparagus, and other plants. This is to be extended to determine whether the effects are due to cold or to anesthesia.

Few changes have occurred in other lines of work. Studies of potato diseases are being made a permanent feature, both from the botanical and bacteriological standpoint, and attempts are being made to produce disease-resistant strains. The cooperative work with the New York State Station on the soft rot of vegetables is nearly completed. Cooperation with the Bureau of Plant Industry has been continued as in previous years on the growth of drug plants. A series of feeding experiments has been conducted with cows on silage from frosted and unfrosted corn and on alfalfa meal versus wheat bran.

The inspection and miscellaneous analytical work continues to be very heavy and consumes a considerable share of the working time of a portion of the staff. Extension work has been conducted through farmers' institutes, and the station actively participated in the management of the "Better farming special" in its trip through the State. During the year the station has lost its assistant botanist and an assistant chemist.

Morrill Hall, the new agricultural building, is in process of erection on a site purchased by the university. This will afford improved facilities for the college of agriculture and for some of the station work.

The publications of this station received during the year were Bulletins 109, 117, 118, Commercial feeding stuffs; 116, 121, Commercial fertilizers; 119, Abstract of Eighteenth Annual Report, 1904–5; 120, Planting white pine in Vermont; and 122, Disease resistance of potatoes; a spraying calendar; and the Annual Reports for 1904 and 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	1,503.51
Fees	2,805.00
Individuals	22.65
Total	24,331.16

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The relations of the station to the university farm are not such as to lead to a strengthening of its work in field and feeding experiments, and in other respects its special needs and the purpose of its funds do not seem to be fully realized. The station has an

appreciative constituency and there is much demand for its work and advice. There is all the more need, therefore, that every obstacle to its development to the fullest extent of the funds at its disposal should be removed.

VIRGINIA.

Virginia Agricultural Experiment Station, *Blacksburg.*

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

A. M. SOULE, B. S. A., *Director.*

The work of the Virginia Station has developed during the year, and will be further strengthened by the completion of the agricultural building now in process of erection, as this will permit greater concentration of the various departments. Some special facilities have been provided, including a refrigerating plant for cold-storage tests, a battery of five greenhouses, and two large fermentation cellars for the mycological investigations on the production of cider, vinegar, and other fruit by-products. A number of changes in the staff have taken place, among them the retirement of R. J. Davidson as chemist, after many years' service, and the promotion of the assistant chemist to this position.

The last legislature made an annual appropriation of $5,000 for the maintenance and support of the station. About half of this fund is being expended in tobacco investigations in cooperation with the Bureau of Soils. Work has been undertaken at West Appomattox in the dark tobacco belt and at Chatham in the light tobacco belt. The problems being investigated are soil preparation, cultivation, and fertilization. Some work is also being done on the selection and improvement of tobacco, and especially as to the handling and curing of the crop.

A portion of the fund is also being used for horticultural work and in experiments relating to the feeding and nutrition of beef cattle. The horticulturist is devoting considerable attention to dwarf nursery stock and now has orchards of both dwarf and standard varieties. Fertilizer trials are proceeding with both sorts, and breeding work on the application of Mendel's law to tomatoes has been taken up. Some feeding trials with pigs are being carried on, and an experiment in finishing steers on various roughages has been completed. The improvement of grade cattle is being sought through breeding to selected bulls.

In the field work the comparison of different varieties of grain as to stooling has shown a great difference in the effect of the improvement and selection of seed. There have also been studies of the prevalence of barren stalks of corn, and work on seed potatoes, seed corn improvement, inoculation for cowpeas and soy beans, and fertilizer

experiments, variety tests of cereals, rotation experiments, soil improvement, etc.

The veterinarian is working on spinal meningitis in horses which has been assumed to be due to mold on feed. As yet it has not been found possible to infect animals with the disease from this source. A device for the treatment of milk fever has been perfected which simplifies the method of treatment and reduces the cost of the necessary apparatus.

The chemical work has been given more definite form and is better differentiated from the college work than formerly. A study has been undertaken of problems relating to the fixation of various mineral elements in soils as influenced by crop rotations and by the addition of chemical elements. The investigation is being carried on with soils of different types in the State.

Cooperative experiments have been undertaken to a limited extent with farmers of the State. The station is distributing cultures for use with legumes, ferments for the making of cider, and a limited quantity of the best varieties of grain. The principal extension work has been through the farmers' institutes, which continue to grow. More than 1,000 farmers visited the station during the month of July. Various members of the station staff have given lectures on elementary agriculture, nature study, and related topics before schools and colleges in the State, and teachers in summer normal schools. This work is having a wholesome effect, and as a result there is greater interest in the teaching of elementary agriculture in the public schools. Considerable improvement has been accomplished in the rural schools of the State, and in the establishing of consolidated and high schools giving instruction in agriculture.

The publications received from this station during the year are as follows: Bulletins 154, The inoculation and cultivation of alfalfa; 155, Meteorological data and bloom notes of fruits; 156, Gluten and cotton-seed meal with silage, hay, and stover for dairy cows; 157, Silage, hay, and stover in beef making; 158, Milk fever—its causes, symptoms, and successful treatment; and 159, Soil inoculation with artificial cultures; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Miscellaneous	142.60
Total	20,142.60

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The Virginia Station has some important work under way and the opportunities afforded with the new buildings and laboratories and additional funds give much encouragement for the future. The feeling toward the station in the State is greatly improved, and it has a strong and enthusiastic following.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman*.

Department of the State College of Washington.

E. A. Bryan, M. A., LL. D., *Director*.

The work of the Washington Station has not materially changed in its main features, although there have been several changes in personnel and considerable extension in animal husbandry, agronomy, and horticulture. A dairyman has been appointed to conduct a traveling dairy school, to study conditions of dairy production in the State and to introduce better methods. Additional assistants in animal husbandry, horticulture, entomology, and veterinary science have been provided.

The work in the improvement of cereals has been greatly extended, and in cooperation with the chemist studies are being made of the chemical composition of the wheats of the region and the baking properties and other characteristics of the flours produced from them. Plant breeding experiments with wheat, and field experiments with cereals, as well as with other crops, are being made at the stations at Quincy and at Ritzville, and tests of varieties of corn, clover, grasses, and other forage plants are being carried on. Special attention has been given to a study of rotations and methods of culture to take the place of the fallow system commonly practiced in the Palouse wheat-growing region. The substitution of a crop of corn or potatoes for bare fallow has been tried with very satisfactory results.

The plantations of native forest seedlings and ornamentals have been extended, and among other lines of work recently undertaken are propagation of nursery stock, soil mulches and cover crops, time of pruning, tests of varieties and training of raspberries and other small fruits, seedling Logan berries, and tests of varieties and methods of culture of vegetables, especially with reference to blight resistance of tomatoes. Attention has also been given to the subjects of clean milk, transmission of tuberculosis, red water in cattle, extermination of squirrels by means of a contagious disease, occurrence of tuberculosis in poultry, and fattening beef cattle on the common forage crops of eastern Washington.

Investigations with reference to various plant diseases and insects and the means of repression have included, among other subjects,

spraying for the codling moth, studies of the hop louse, crown gall, the occurrence of the Hessian fly recently reported in the vicinity of Portland, and the efficacy of quassia sprays.

The chemistry of forage plants, of fruit ripening, and of lard, availability of fertilizers, and cooperative fertilizer experiments on different soil types have continued to receive attention, and experiments in the application of water to crops have been conducted in the irrigated districts.

The publications of this station received during the year were Bulletins 67, Some notes regarding Halphen's test for cotton-seed oil—reaction of lard from cotton-seed meal fed hogs with Halphen's reagent—effects of feeding cotton-seed meal upon the health of animals; 68, The wormy apple; 69, Preliminary report on the codling moth in the Yakima Valley; 70, The powdery mildews of Washington; 73, Feeding wild plants to sheep; 75, Apple scab in eastern Washington; and 76, The economical preparation of the sulphur-lime spray.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	757.95
Total	20,757.95

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The work of the Washington Station is developing in several important lines. The strengthening of its organization by the appointment of a director apart from the office of president, who can give his time largely to attending to the affairs and interests of the station, continues to be greatly needed. In a large State like Washington, with its diverse agricultural conditions and interests, the station management requires more time than a president of a growing college can devote to it to develop its full efficiency and usefulness.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University.

J. H. Stewart, M. A., *Director.*

The West Virginia Station is making progress along the lines of previous years. During the year an investigation of the mummy disease of guavas has been completed and fertilizer trials for peach trees, spraying experiments for potatoes and melons, and cooperative

trials of cover crops with orchardists have been continued. A plant disease survey has been made of the State.

Among other investigations completed during the year are studies of nitro cultures and an examination of the limestones and salt brines of the State, the latter with special reference to cattle poisoning.

The chemist has resumed his studies on the effect of pressure on the preservation of fruit juices, using pressures as high as 30,000 pounds to the square inch. Juices so treated have been kept without deterioration for two years. An attempt is being made to obtain a noncorrosive can lining. A new pressure machine is being constructed for the station work which will enable larger quantities of juice to be treated. The chemist is also continuing his studies of the production of nitric acid from the atmosphere by means of pressure.

The entomologists are working out the life history of the woolly aphis and the relative immunity of apple trees to it. A single tree has been found which seems to be immune, and some immune stock from Australia has been imported for grafting. The snout beetles infesting nuts, especially the chestnut and hickory, are also being investigated and the egg-laying process of the hickory weevil has been worked out.

Commercial problems form the main features of the work of the agricultural department. A house holding over 700 hens has been built for poultry raising on a large scale. An Ayrshire-Jersey cross is being developed for milk production, the objects sought being a larger yield and smaller fat globules. A refrigerating plant and complete modern dairy equipment have recently been installed, mainly for demonstration of improved methods in marketing milk for city trade and studies of the changes in milk at low temperatures.

From this station the following publications have been received: Bulletins 94, Diseases of melons and cucumbers during 1903 and 1904; 96, A report on plant diseases of the State; 97, Commercial fertilizers; 99, Experiments with fertilizers; 100, The grape curculio; 104, The ripe rot or mummy disease of guavas; and 105, Tubercles on legumes with and without cultures; and a report on nursery and orchard inspection, 1904–5.

The income of this station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
Fees	9,066.94
Farm products	3,672.54
Total	32,739.48

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

Cooperative and extension work is conducted by the station along several lines, including soil tests, tuberculin tests of herds, the eradication of the stomach worm of sheep by means of a coal-tar creosote, and poultry raising, and under a State appropriation in the controlling of insects and plant diseases.

The station work is attracting more attention from the people of the State than formerly. It is managed in a businesslike way and in the interests of the farmers and horticulturists of the State, having due regard for the development of various specific phases of agriculture. The station and college work are quite fully differentiated.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison.*

Department of the University of Wisconsin.

W. A. Henry, D. Agr., D. Sc., *Director.*

The Wisconsin Station has brought to a close an extensive series of investigations of the losses of butter fat in cheese making. It is believed that by the use of separators and other improved methods enough whey butter can be obtained to yield an increased profit to the industry of at least $150,000 a year. Swiss cheese manufacture has been continued, and further studies have been made of the action of various yeast ferments and the use of square vats in place of the expensive and awkward round copper kettles now claimed to be absolutely essential. The inhibitory influence of nickel and iron on rennet and the influence of the richness of the milk on the quality of the cheese are also being studied. The relative value of vegetable and aniline butter colors is being tested, and progress has been made in the investigation of problems of dairy sewage disposal.

In animal husbandry a study is being made of the relative economy of medium and high protein rations for milk production, with the object of introducing more farm grains into the rations of dairy cattle. The value of the dual purpose cow for milk and beef as compared with the special purpose breeds is also receiving attention. The feeding and breeding of pigs and sheep continue to be prominent features. Grinding corn has been found unprofitable in fattening hogs, as the saving of feed is too small to meet the cost of grinding. A comparison of the bacon and lard types for pork production has been inaugurated. Beet pulp is being tried as a food for sheep, and the experiments on raising winter lambs have been continued.

In horticulture extensive experiments to improve the native wild plum are drawing to a close. From thousands of seedlings a few choice varieties adapted to Wisconsin conditions have been secured

and will be propagated for limited distribution. Experiments on the cultivation, fertilizing, curing, and hybridizing of tobacco are in progress, as well as studies of the resistance of varieties of potatoes to blight and of spraying for protection against it. Demonstration experiments in fruit growing are being conducted in the Lake Superior region, together with numerous variety tests. Breeding experiments are being carried on with a number of varieties of plants, particularly as to the effect of excessive nutrition as a means of inducing variation. In this way the seedless tomatoes illustrated in Plate VI have been produced at will.

Studies of tuberculosis have shown that the feeding of skim milk from creameries to calves and pigs has been an important means of dissemination. The effects of tuberculin testing on milk secretion are also being studied, as well as the occurrence of leucocytes in milk and the distribution of lactose-fermenting yeasts through the State. Soil studies are being made of the various types, the effect of continuous cropping is being studied with a large number of soil samples that have been collected, and field tests of untreated rock phosphates are under way. In agronomy, the cereal breeding work with corn, barley, alfalfa, and soy beans is progressing satisfactorily, and weed eradication has been taken up. It has been found that by spraying with iron sulphate solution it is possible to destroy wild mustard (Pl. VII), oxeye daisy, cockle burs, and ragweed in oat fields without injury to the oat crop. The strength used has been about 100 pounds of iron sulphate to 50 gallons of water per acre, and the cost of material from 60 to 75 cents per acre—much less than for a copper sulphate solution.

The cooperative and extension work of the station continue to be very large. The irrigation work which has been carried on in cooperation with this Office has been closed, but statistics on drainage areas are being collected. The cranberry investigations are continued with State funds, and in cooperation with the Weather Bureau stations have been maintained from which frost warnings may be sent to growers. There is also cooperation with the Bureau of Animal Industry in methods of cheese manufacture, with the State live-stock sanitary board in the suppression of bovine tuberculosis, with the Wisconsin Agricultural Experiment Association in cereal testing, and very largely directly with the farmers of the State in tobacco growing, potato spraying, drainage, etc. (Pl. VIII.)

The publications of this station received during the year were: Bulletins 127, The principles and practice of horse breeding; 128, A Swiss cheese trouble caused by a gas-forming yeast; 129, Some creamery problems; 130, Licensed commercial feeding stuffs, 1905; 131, Official tests of dairy cows, 1904–5; 133, Distribution of tuber-

FIG. 1.—AN INTERMEDIATE TYPE OF TOMATO, NEARLY SEEDLESS.

[Modification brought about by high feeding. Form, size, and quality the best.]

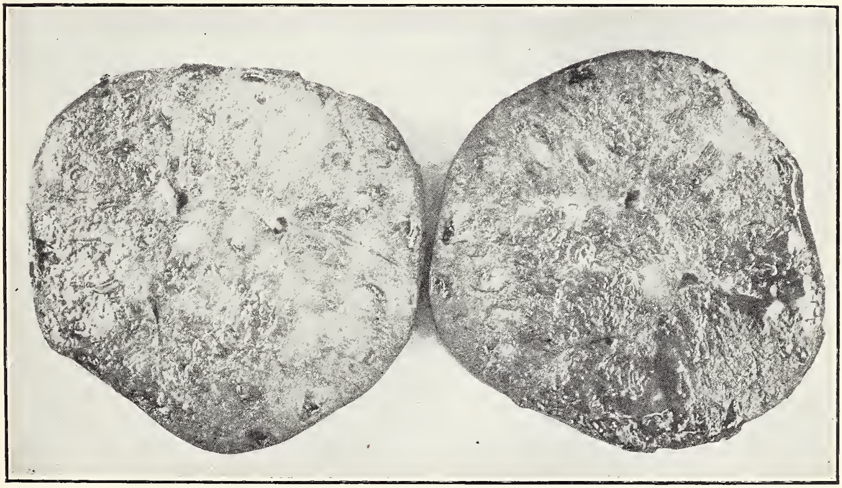

FIG. 2.—LARGE TYPE SEEDLESS TOMATO.

SEEDLESS TOMATOES BRED AT WISCONSIN STATION.

FIG. 1.—FIELD TO LEFT SPRAYED, STRIP ON RIGHT UNSPRAYED.

[Showing mustard plants in blossom three weeks after spraying.]

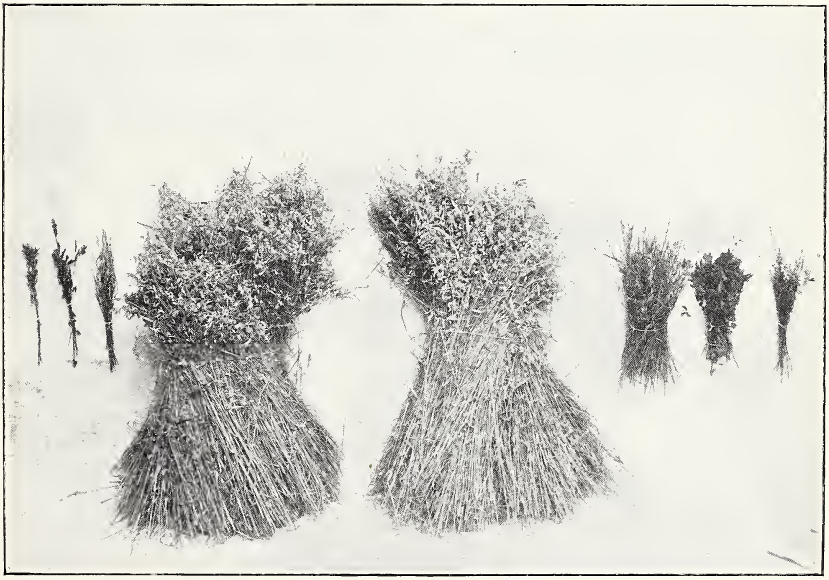

FIG. 2.—ON LEFT, OATS AND WEEDS FROM THREE HARVESTER BUNDLES FROM TREATED PLAT; ON RIGHT, SAME FROM UNTREATED PLAT.

EFFECT OF SPRAYING OAT FIELDS WITH IRON SULPHATE SOLUTION FOR ERADICATION OF WILD MUSTARD.

FIG. 1.—CORN GROWN ON UNDRAINED FIELD.

FIG. 2.—CORN GROWN ON FIELD WITH TILE DRAINS 70 FEET APART.

FIG. 3.—CORN GROWN ON FIELD WITH TILE DRAINS 40 FEET APART.

[Originally the wettest portion of the area.]

RESULTS OF EXPERIMENTS IN TILE DRAINAGE ON HEAVY LACUSTRINE CLAY, WISCONSIN STATION.

culosis in suspected and nonsuspected herds in Wisconsin; 134, Licensed commercial fertilizers and feeding stuffs, 1906; and 135, Spraying potatoes for prevention of leaf blight and rot.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	[a] 18,500.00
Fees	2,600.00
Total	41,100.00

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

During the year provision has been made for the erection of farm engineering and agronomy buildings for the college of agriculture. A tobacco shed has been built solely for experimental purposes, and several tracts of land have been secured and improved. Through the efforts of the college and station a law has been enacted requiring the licensing by the college of all stallions in the State for which service fees are charged. This law, which is the first of its kind in this country, has already resulted in the elimination of a large number of low-grade stallions.

The college continues to make rapid growth, and a number of additions have been made, both to its staff and to that of the station. An attempt is being made to differentiate the work to a greater extent than formerly.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie.*

Department of the University of Wyoming.

B. C. Buffum, M. S., *Director.*

The work of the Wyoming Station has in a large measure passed the pioneer stage of merely testing the adaptability of crops and methods of farming to high altitudes and arid region conditions. The station has shown that oats, barley, wheat, rye, and other cereals, potatoes and other root crops, alfalfa, peas, spelt, and a great variety of other forage plants and many kinds of fruits and vegetables can be successfully grown under conditions which were formerly thought to debar successful farming, and has convinced the ranchman that many of these products can be utilized to make his stock raising more profitable. In consequence, stock feeding for marketing in finished form has been added to stock raising as formerly carried on. This has brought about better methods of management, increased care of ani-

[a] Including $2,000 for cranberry investigations and $1,500 for tobacco investigations.

mals, and the raising of winter feed for the better maintenance of stock. Having thus in a large measure met the more pressing practical needs of the agriculture of the State, the station is now in position to direct its attention to more advanced investigation.

During the past year the work in agronomy has been confined mainly to experiments with a number of farm crops. Special studies have been made of barley for brewing purposes, of disease-resistant potatoes, and of the deterioration of seed potatoes. Horticultural work is being developed at Lander under a State appropriation. In animal industry attention is being given mainly to the economical feeding of cattle, sheep, and swine, the breeding of polled Herefords, and incidentally to the influence of high altitudes and aridity on the hatching of eggs. Through the cooperation of the chemical department the digestibility and nutritive value of native and introduced grasses and grains are being determined.

The farmers' institutes and short courses, some of which are in effect protracted farmers' institutes, are accomplishing much good but make serious inroads on the time and energies of the station staff. The development of the short-course work and the introduction of secondary instruction in the college are being considered.

The publications of this station received during the year were Bulletins 65, Wyoming forage plants and their chemical composition; 66, Irrigation work on the North Platte River; 67, Duty of water; 68, Ration experiments with lambs, 1904–5; and the Annual Report for 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act	$15,000.00
United States appropriation, Adams Act	5,000.00
State appropriation	177.26
Farm products	2,608.30
Total	22,785.56

Reports of the receipts and expenditures for the United States funds have been rendered in accordance with the schedules prescribed by this Department and have been approved.

The station is making good use of the funds at its disposal and is steadily increasing the grade and efficiency of its work. Supplementary funds for additional equipment should be forthcoming, especially on the farm, in order that the increased Federal funds may be used to the best advantage.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

OFFICERS.

President.

L. H. Bailey, of New York.

Vice-Presidents.

T. D. Boyd, of Louisiana.
M. A. Scovell, of Kentucky.
B. C. Buffum, of Wyoming.
R. W. Stimson, of Connecticut.
C. G. Hopkins, of Illinois.

Secretary-Treasurer.

J. L. Hills, of Vermont.

Bibliographer.

A. C. True, of Washington, D. C.

Executive Committee.

H. C. White, of Georgia.
J. L. Snyder, of Michigan.
W. H. Jordan, of New York.
C. F. Curtiss, of Iowa.
W. E. Stone, of Indiana.

Sections.

Section on College Work and Administration: E. A. Bryan, of Washington, chairman; H. C. Price, of Ohio, secretary.

Section on Experiment Station Work: M. A. Scovell, of Kentucky, chairman; C. E. Thorne, of Ohio, secretary.

TWENTIETH ANNUAL CONVENTION.

GENERAL SESSIONS.

The twentieth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held in Baton Rouge, La., November 14–16, 1906. The meeting was an unusually large one, and, as has generally been the case in recent years, it was made the occasion for the meeting of several societies and associations not affiliated with the association, although related to it in work. Among these were the Associations of State Universities, of Farmers' Institute Workers, and of Horticultural Inspectors, the Society for the Promotion of Agricultural Science, and the Economic Entomologists of the Cotton Belt.

The annual address of the president of the association, M. H. Buckham, of Vermont, was in the main a plea for placing greater emphasis upon the liberal and humanistic culture studies in the curriculum as a means of preventing narrowness and crudeness of thought and character. He maintained that while the function of the land-grant colleges is to produce industrial experts, they should be liberally educated. (See also p. 233.)

The report of the executive committee reviewed the work of that committee during the year with reference to the passage of the Adams Act and its interpretation, initial steps with reference to the establishment of a department of rural education in the National Educational Association, and negotiations with the trustees of the Carnegie Foundation for the Advancement of Teaching with reference to including the land-grant colleges among the beneficiaries of that institution. H. C. White, chairman of the executive committee, was designated by that committee as its representative to present the last-named matter to the trustees of the Carnegie Foundation at a meeting held November 21, 1906. The association passed a resolution expressing its gratitude to the executive committee for its painstaking and efficient efforts in connection with the passage of the Adams Act.

The bibliographer, A. C. True, presented as his report a list of 385 books, the work of 195 men and women now or at one time connected with agricultural colleges or experiment stations. (See p. 234.)

Memorial addresses and appropriate resolutions relating to the life and work of President George W. Atherton and Hon. Henry Cullen Adams were presented.

The committee on instruction in agriculture presented through its chairman, A. C. True, a brief report explaining the organization of the committee into subcommittees on (1) elementary courses, (2) secondary courses, (3) courses in home economics, and (4) courses in rural engineering. These subcommittees have in preparation reports on the subjects assigned them, which it is expected will be published through this Office. In the discussion following this report there was a general expression of interest in the work and a desire for the early publication of the results of the committee's studies. (See also p. 234.)

The report of the standing committee on graduate study, by Chairman L. H. Bailey, consisted of a brief account of the second session of the Graduate School of Agriculture held at the University of Illinois during the summer of 1906. Explaining the purpose of this school, the report says:

> This graduate work stands for a kind of teaching that lies beyond the college grade and that makes strongly for originality and personality. This enterprise expresses the conviction of the association that agricultural subjects are as capable as any others of advanced study, that they have equal and similar pedagogical value, and that there is need of the pursuit of them. * * * The

unqualified success of the second session of the graduate school established the fact that graduate work is in demand. This school is now the only meeting ground for teachers and investigators in agriculture. The comradeship of it is itself worth the while. * * * The experience with the two sessions of the graduate school indicates that no agricultural college or experiment station can afford not to partake in it if the institution expects to keep in living touch with the knowledge and opinions of the day.

For a fuller account of this school see page 236.

The report of the committee on extension work[a] presented by K. L. Butterfield, chairman, defines and classifies such work, summarizing the present status of agricultural extension teaching in the United States and recommending that each college establish as soon as practicable a department for such teaching coordinate with other departments. The association placed itself on record as strongly favoring adequate appropriations to the Office of Experiment Stations to enable it to enlarge its work on agricultural education, especially with reference to the organization of agricultural extension teaching. (See also p. 235.)

The report of the committee on station organization and policy,[b] presented by the chairman, E. Davenport, dealt largely with questions growing out of the interpretation of the Adams Act and the organization of work under that act. (See p. 71.)

The relations of the Bureau of Education with land-grant colleges were reviewed by L. A. Kalbach, of that Bureau. It was shown that the number of agricultural students at these institutions has increased during the past ten years from 2,712 to 7,418, and the students in mechanic arts from 5,317 to 12,969. The State appropriations have increased from $1,789,235 to $5,768,786, the total income of the colleges during the last year being over $11,500,000.

A proposal to cooperate with the Association of State Universities in memorializing Congress to establish a National University at Washington was quite fully discussed and finally disposed of by reference to the executive committee to take such action as in its judgment seemed wise, and to make a full report to the association at its next meeting.

An important matter affecting the policy of agricultural research in this country was presented for discussion in a resolution presented by H. P. Armsby, calling for the appointment by the incoming president of the association of a commission consisting of five persons, two representing the research efforts of the association, one the United States Department of Agriculture, and two representing the scientific men not connected with official agricultural investigation, "the duty of which shall be to inquire into and report to this asso-

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[a] This report has been published as U. S. Dept. Agr., Office Expt. Stas. Circ. 72.

[b] This report has been published as U. S. Dept. Agr., Office Expt. Stas. Circ. 71.

ciation the organization and policy which, in the opinion of the commission, should prevail in the expenditure of public money provided for scientific experimentation and research in the interests of agriculture, to the end that such funds shall be applied in the most economical, efficient, and worthy manner to the production of results of permanent value."

The discussion of this resolution indicated a general feeling that for the purposes of research the various agencies in this country, partly from lack of system, have not been as efficient as they might be made, and that much good might come from an impartial survey of the whole field by men competent to analyze the situation and to plan broadly. The resolution was adopted.

The association put itself on record as favoring an attempt to secure increased Federal appropriation for education in agriculture and mechanic arts, and instructed its executive committee to cause a measure drawn on the same general lines as the second Morrill Act, to be introduced in Congress.[a]

SECTION ON COLLEGE WORK AND ADMINISTRATION.

In the section on college work and administration the main topics of discussion were: (1) Administration of the land-grant colleges—organization and classification of the instructional force, control of student activities and student labor; (2) relation of the land-grant college to the public school system, to the agricultural industries, and to the mechanical industries; and (3) curriculum of the land-grant college—study of home economics in the land-grant college, the short practical course, its place and importance, and agricultural extension. (For a fuller account see p. 235.)

SECTION ON EXPERIMENT STATION WORK.

In the section on the experiment station work attention was devoted principally to discussion of questions relating to the Adams Act and agricultural research in general. The Director and the Assistant Director of this Office explained the provisions and limitations of the Adams Act, plans for the administration of the funds under it, and some of the difficulties experienced by the stations in inaugurating work under the act. H. P. Armsby urged that the stations should consider not so much the legal requirements as the opportunities for advanced scientific work offered under the act, and a recognition of

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[a] Such a measure was introduced into both branches of the Fifty-ninth Congress, second session. The appropriation was, however, finally provided for by a clause in the appropriation act of this Department for the fiscal year ending June 30, 1908, which increases the appropriation for each land-grant college $5,000 annually for five years.

the need and desirability of the more advanced work contemplated under the Adams Act was generally expressed. A resolution recording approval of the methods adopted by the Office of Experiment Stations in administering the Adams Act was passed by the section.

Three carefully prepared papers were presented before the section—one on Problems of Animal Nutrition, by H. P. Armsby; another on Methods of Experimentation in Feeding for Meat Production, by H. W. Mumford, and the third on Methods of Experimentation in Feeding for Milk Production, by J. L. Hills.

A report of the committee on unification of terms used in chemical analysis was presented by C. G. Hopkins, chairman. The report was accepted, and the committee was continued with instructions to seek to bring about an agreement for uniform usage among chemists.

STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1906.

By Miss M. T. Spethmann.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of July 2, 1862. These statistics have been compiled in part from replies to a circular of inquiry sent out from the Office of Experiment Stations, and in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, August 30, 1890, and March 16, 1906, prepared from figures furnished by the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1906 is estimated to be as follows: Land-grant fund of 1862, \$12,500,558.29; other land-grant funds, \$3,988,068.60; other permanent funds, \$13,829,945.72; land grant of 1862 still unsold, \$4,005,736.10; farms and grounds owned by the institutions, \$7,873,237.68; buildings, \$30,322,457.04; apparatus, \$2,432,339.88; machinery, \$2,831,046.06; libraries, \$2,819,614.26; live stock, \$369,913.13; miscellaneous equipment, \$3,222,469.12; total, \$84,195,385.88. The income of these institutions in 1906, exclusive of the funds received from the United States for agricultural experiment stations (\$867,617.70), was as follows: Interest on land-grant funds of 1862, \$758,753.34; interest on other land-grant funds, \$106,185.17; United States appropriation under act of 1890, \$1,200,000; interest on endowment or regular

appropriation, $122,980.94; State appropriation for current expenses, $4,308,150.34; State appropriations for buildings or for other special purposes $3,088,947.32; income from endowment, other than Federal or State grants, $677,138.21; tuition fees, $993,003.38; incidental fees, $631,936.99; miscellaneous, $1,659,663.77; total, $13,546,759.46. The value of the additions to the permanent endowment and equipment of these institutions in 1906 is estimated as follows: Permanent endowment, $1,215,084.73; buildings, $1,745,118.99; libraries, $452,-963.23; apparatus, $227,340.63; machinery $134,800.20; live stock, $56,244.87; miscellaneous, $133,597.19; total, $3,965,149.84.

The number of persons in the faculties of the colleges of agriculture and mechanic arts was as follows: For preparatory classes, 480; for collegiate and special classes, 2,454; total, counting none twice, 3,020. In the other departments the faculties aggregated 1,667, making a grand total of 4,687 persons in the faculties of the land-grant institutions.

The students in 1906 in the colleges for white persons were as follows: (1) By classes—preparatory, 5,890; collegiate, 22,823; short course or special, 5,695; postgraduate, 517; other departments, 22,038; total, counting none twice, 56,919. (2) By courses: *Four-year*—agriculture, 2,779; horticulture, 132; household economy, 926; mechanical engineering, 4,351; civil engineering, 3,730; electrical engineering, 3,166; mining engineering, 1,061; chemical engineering, 377; architecture, 281. *Shorter than four years*—agriculture, 3,883; dairying, 720; horticulture, 161; veterinary science, 821; military tactics, 17,372.

The students in colleges and schools for colored persons were as follows: (1) By classes—preparatory, 4,544; collegiate, 682; short or special, 310; other departments, 1,016; total, 6,552. (2) By courses—agriculture, 1,798; industrial courses for boys, 2,106; industrial courses for girls, 4,120; military tactics, 1,798.

The graduates in 1906 were 5,220, and since the organization of these institutions, 67,122. The average age of graduates in 1906 was 22 years and 3 months. The total number of volumes in the libraries was 2,464,642. The total number of acres of land granted to the States under the act of 1862 was 10,320,842, of which 798,053 are still unsold.

SUMMARY OF STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, and Porto Rico.

In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained, wholly or

in part, by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the acts of 1887 and 1906 during 1906 was $2,017,492.12, of which $960,000 (Hatch fund $720,000, Adams fund $240,000) was received from the National Government, the remainder, $1,057,492.12, coming from the following sources: State Governments, $709,902.05; individuals and communities, $8,304.37; fees for analyses of fertilizers, $100,186.57; sales of farm products, $135,526.96; miscellaneous, $103,572.17. In addition to this the Office of Experiment Stations had an appropriation of $197,900 for the past fiscal year, including $18,000 for the Alaska experiment stations, $15,000 for the Hawaii Experiment Station, $15,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, $74,200 for irrigation and drainage investigations, and $5,000 for farmers' institutes. The value of the additions to the equipment of the stations in 1906 is estimated as follows; Buildings, $169,875.50; libraries, $22,080.29; apparatus, $57,439.98; farm implements, $22,706.52; live stock, $51,977.68; miscellaneous, $22,812.75; total, $346,892.72.

The stations employ 950 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 52; assistants and vice-directors, 17; special agents in charge, 3; chemists, 171; agriculturists, 47; agronomists, 68; animal husbandmen, 72; poultrymen, 12; horticulturists, 101; farm and garden foremen, 31; dairymen, 45; botanists, 54; plant pathologists, 21; entomologists, 76; zoologists, 4; veterinarians, 36; animal pathologists, 3; meteorologists, 8; foresters, 9; mycologists, 5; biologists, 3; physicists, 5; geologists, 7; bacteriologists, 25; irrigation engineers, 13; in charge of substations, 26; secretaries and treasurers, 32; librarians, 14; clerks and stenographers, 55. There are also 64 persons classified under the head of "miscellaneous," including superintendents of grounds and buildings, gardeners, farm mechanics, laboratory assistants, etc. Four hundred and thirty-four station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 463 annual reports, bulletins, and circulars, which were supplied to over 758,000 addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers, on a wide variety of topics.

STATISTICS OF THE LAND-GRANT COLLEGES AND UNIVERSITIES.[a]

Unless otherwise specified, the statistics reported in the tables are for the institutions as designated in the list given below:

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate). Four-year courses and degrees.	Collegiate courses of study (undergraduate). Short courses.
Alabama	Alabama Polytechnic Institute.	Auburn	C. C. Thach, M. A., LL. D.	Chem. and agr., civil engin., elect. engin., mech. engin., mining engin., phar., general, chem. and metal. (B. S.).	Agr., mech. arts, phar. (2 yrs.), phar. (3 yrs.), agr. (1 yr.), summer school for farmers (10 days).
	Agricultural and Mechanical College for Negroes	Normal	W. H. Councill, Ph. D.	Sci. (B. S.), agr. (B. A. S.), mech. (B. M. S.).	Indus. and lit. studies (1 to 4 yrs.).
Arizona	University of Arizona	Tucson	K. C. Babcock, Ph. D.	Lit. (Ph. B.), sci., chem., mining engin., civil engin., mech. engin. (B. S.).	Mineralogy and assaying (2 yrs.), prep. (4 yrs.).
Arkansas	University of Arkansas.	Fayetteville	J. N. Tillman, B. L. L.	Agr. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), mining engin. (B. Mi. E.), chem. engin. (B. Ch. E.), chem. (B. S. C.), lit. and sci. (B. A. and B. S.), music (B. Mus.), normal, art.	Agr., hort., dairying, elect. engin. (2 yrs.), mech. arts (2 or 3 yrs.), prep. (2 yrs.), agr. (2 weeks).
	*Branch Normal College.	Pine Bluff	Isaac Fisher	Collegiate (B. A.), normal (L. I.), manual training, mech. arts.	Prep. (3 yrs.).
California	University of California.	Berkeley	B. I. Wheeler, Ph. D., LL. D.	Letters (B. A.), social sci. (B. L.), natural sci., commerce, agr., mech. engin., elect. engin., mining engin., civil engin., chem., sugar technol. (B. S.).	Prep. med. (3 yrs.), agr., animal indus., dairying (6 weeks), nutrition (3 weeks), ent. (4 weeks), vit. (4 weeks), summer session (6 weeks).
Colorado	The State Agricultural College of Colorado.	Fort Collins	B. O. Aylesworth, A. M., LL. D., Litt. D.	Agr., mech. engin., civil and irrig. engin., general and domestic sic., hort. (B. S.).	Agr., normal course in domestic sci., domestic sci. and agr., prep. (2 yrs.), agr. (2 months).
Connecticut	Connecticut Agricultural College.	Storrs	R. W. Stimson, A. M., B. D.	Agr. or hort., home econ. (B. S.)	Agr. or hort., mech., home econ., nature study (2 yrs., diploma), summer school for teachers in nature and country life (3 weeks), farm dairying, creamery, pomol. (winter, 12 weeks), poultry (6 weeks), 32 ten-day courses.
Delaware	Delaware College	Newark	G. A. Harter, M. A., Ph. D.	Clas., Lat. sci. (B. A.), agr., general sci., civil engin., mech. engin., elect. engin. (B. S.).	Agr. (1 or 2 yrs.), agr. (winter, 10 weeks).
	State College for Colored Students.	Dover	W. C. Jason, M. A., B. D.	Clas. (B. A.), sci. (B. S.), agr. (B. Agr.), engin. (B. E.).	Normal (3 yrs.), industrial (2 yrs.), prep.

Florida	University of Florida	Gainesville	Andrew Sledd, Ph. D., LL. D.	Lit. (B. A.), gen. sci., agr., mech. engin., elect. engin., civil engin. (B. S.), pedag. (B. A. in Ped.).	Normal (4 yrs.), agr., mech. arts., pedag. (2 yrs.), summer school for teachers (6 weeks).
	Florida State Normal and Industrial School.	Tallahassee	N. B. Young, M. A.	....	Normal (2 yrs.), high school, grammar school (3 yrs.), indus. training through all courses.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White, Ph. D., D. C. L., LL. D.	General sci., agr., civil engin., elect. engin. (B. S.).	Agr., hort., dairying (1 yr.), agr. (12 weeks).
	Georgia State Industrial College.	Savannah	R. R. Wright, A. M., LL. D.	Collegiate (A. B.)	Normal (3 yrs.), industrial, prep. (3 yrs.).
Idaho	University of Idaho	Moscow	J. A. MacLean, Ph. D., LL. D.	Clas. (B. A.), agr. and hort., sci., domestic econ. (B. S.), civil engin. (B. C. E.), mining engin. (B. M. E.), elect. engin. (B. E. E.), music (B. M.).	Agr. (4 yrs.), prep. (3 yrs.), dairying and hort. (4–6 weeks).
Illinois	University of Illinois	Urbana	E. J. James, Ph. D., LL. D.	Lit. and arts (B. A.), archi. engin., civil engin., elect. engin., mech. engin., railway engin., municipal and sanitary engin., sci., agr., domestic sci. (B. S.), music (B. M.), libr. sci. (B. L. S.), phar. (Ph. G.), phar. chem (Ph. C.), med. (M. D.), dentistry (D. D. S.).	Law (LL. B.), surgery (D. D. S.) (3 yrs.), summer school (9 weeks), agr. (2 weeks).
Indiana	Purdue University	Lafayette	W. E. Stone, Ph. D.	Mech. engin. (B. S., M. E.), civil engin., sanitary engin. (B. S., C. E.), elect. engin., telephone engin. (B. S., E. E.), agr. (B. S. Agr.), sci., household econ. (B. S.), phar. (B. S. Phar.).	Agr. (2 yrs.), agr., hort., animal husb., dairying (winter, 10 weeks), phar. (2 yrs., Ph. G.).
Iowa	Iowa State College of Agriculture and Mechanic Arts.	Ames	A. B. Storms, A. M., D. D., LL. D.	Agron., dairying, animal husb., hort. sci. and agr. (B. S. A.), vet. med. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. C. E.), elect. engin. (B. S. in E. E.), mining engin. (B. S. in Mn. E.), sci., general and domestic sci. (B. S.), ceramics (B. E. M. in Cer.), domestic sci. (B. D. S.).	Mining engin., clay working (2 yrs.), dairying (1 yr.), dairying (16 weeks), corn and grain judging, stock judging, domestic econ., hort. and forestry (2 weeks each).
Kansas	Kansas State Agricultural College.	Manhattan	E. R. Nichols, A. M.	Agr., mech. engin., general sci., elect. engin., domestic sci., archi. (B. S.), vet. sci. (D. V. M.).	Domestic sci. (2 terms, 12 weeks each), farmers' (2 winter terms, 10 weeks each), farm dairying (10 weeks), dairying (12 weeks).
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson, Ph. D., LL. D.	Clas. (A. B.), mech. engin. (B. M. E.), civil engin. (B. C. E.), mining engin. (B. E. M.), agr. (B. Agr.), sci. (B. S.), pedag. (B. Ped.).	Agr (2 yrs.), prep. (2 yrs.), agr. (winter, 10 weeks), summer school for teachers.
	The Kentucky Normal and Industrial Institute for Colored Persons.	Frankfort	J. S. Hathaway, M. A., M. D.	Normal	Normal, agr., carpentry, cooking, music, dressmaking, printing, blacksmithing, wheelwrighting (3 yrs.), business (1 yr.).
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd, M. A., LL. D.	Agr., elect. engin., sugar chem. and manuf. (5 yrs.), civil engin., mech. engin., general sci., premed. (B. S.), commercial, Lat., sci., lit., philos. and ed. (B. A.).	Law (LL. B.), prep. (1 yr.), agr. (10 weeks), stock, corn, and cotton judging (10 days).

[a] Including also institutions receiving apportionments from the appropriation of 1890.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Four-year courses and degrees.	Short courses.
Louisiana	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill	Clas., sci., agr., mech., normal, printing, music.	Agr., dairying, bookkeeping (2 yrs.) mech., tinsmithing (3 yrs.), typewriting.
Maine	The University of Maine.	Orono	G. E. Fellows, Ph. D., L. H. D., LL. D.	Clas. (B. A.), sci., agr., hort., chem., civil engin., mech. engin., elect. engin., chem. engin., forestry, phar. (B. S.).	Law (3 yrs., LL. B.), agr. (2 yrs.), phar. (Ph. C.) (2 yrs.), agr., hort., and dairying (8 weeks), poultry management and hort. (3 weeks), summer school for teachers (5 weeks), reading and correspondence courses.
Maryland	Maryland Agricultural College.	College Park	R. W. Silvester, M. S.	Agr., hort., chem., gen. sci., mech. engin., civil engin. (B. S.).	Agr. (2 yrs.), agr. (10 weeks), dairying.
	Princess Anne Academy.	Princess Anne	Frank Trigg, M. A.	Academic, normal	Indus.
Massachusetts	Massachusetts Agricultural College.	Amherst	K. L. Butterfield, A. M.	Agr. (B. S.)	Dairy farming, hort. (winter, 10 weeks), bee culture (2 weeks).
	Massachusetts Institute of Technology.	Boston	H. S. Pritchett, Ph. D., LL. D.	Civil engin., mech. engin., mining engin. and metal., archi., chem., elect. engin., biol., phys., electro-chem., chem. engin., sanitary engin., geol., naval archi. elective (B. S.).	
Michigan	Michigan State Agricultural College.	Agricultural College.	J. L. Snyder, A. M., Ph. D.	Agr., engin., forestry, women's (B. S., each 4 and 5 yrs.).	Cheesemaking (4 weeks), creamery management, live stock and general farming, fruit culture (8 weeks each).
Minnesota	The University of Minnesota.	Minneapolis	Cyrus Northrop, LL. D.	General (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), mining, metal. (E. M., Met. E.), chem. (A. C. or C. T.), agr. (B. S. Agr.), forestry (B. S. For.), home econ. (B. S.).	Agr. (3 yrs.), home econ. (3 yrs.), agr. (8 weeks), dairying (4 weeks).
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	J. C. Hardy, A. M., LL. D.	Agr., hort., dairying, vet. sci., chem., mech. engin., phys. and elect. engin., civil and rural engin., geol. and mining, textile (B. S.).	Agr., mech. arts, elect. engin., textile (2 yrs.), prep. (1 yr.), agr. (10 weeks), summer normal school for teachers (5 weeks).
	Alcorn Agricultural and Mechanical College.	Lorman	L. J. Rowan, B. S.	Scientific (B. S.)	Business, carpentry, agr., shoemaking, blacksmithing, painting, domestic sci., millinery, etc. (3 yrs.), prep. (2 yrs.).
Missouri	University of Missouri.	Columbia	R. H. Jesse, LL. D.	Agr. (B. S.), civil engin. (B. S., C. E.), mech. engin., mining engin. (B. S., M. E.) elect. engin. (B. S., E. E.), sanitary engin., chem. engin., hydraulic engin., metal. (B. S.).	Plant production, animal husb., dairying (8 weeks), summer school for teachers (8 weeks).
	Lincoln Institute	Jefferson City	B. F. Allen, A. M., LL. D.	Collegiate (B. A.), normal	College prep., normal prep., carpentry, blacksmithing, mach. work, sewing, cooking, laundering (3 yrs.).

Montana	The Montana State College of Agriculture and Mechanic Arts.	Bozeman	J. M. Hamilton, M. S.	General sci., domestic sci (B. S.), agron., animal husb., dairying, hort. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), art, music.	Agr. (3 yrs.), pract. mech. (2 yrs.), prep- (3 yrs.), domestic sci., water measuring (1 yr. each).
Nebraska	The University of Nebraska.	Lincoln	E. B. Andrews, LL. D.	Clas., lit. (B. A.), general sci., agr., home econ., civil engin., elect. engin., steam engin., municipal engin., mech. engin., premed., tech. forestry (B. S.), med. (M. D.).	Agr. (3 yrs.), law (LL. B., 3 yrs.), mining engin. (3 yrs.), mech. arts (2 yrs.), dairying, agr. (9 weeks), summer session (6 weeks), judging (1 week), art, music.
Nevada	Nevada State University.	Reno	J. E. Stubbs, M. A., D. D., LL. D.	Liberal arts (B. A.), mining and metal., agr., domestic sci., mech. engin., civil engin., general sci. (B. S.).	Agr. dairying, bot., ent., bact., domestic sci., assaying (3 months).
New Hampshire.	The New Hampshire College of Agriculture and Mechanic Arts.	Durham	W. D. Gibbs, M. S.	Agr., mech. engin., elect. engin., chem. engin., general (B. S.).	Agr. (2 yrs.), agr. (winter, 10 weeks), dairying (10 weeks).
New Jersey	Rutgers Scientific School, The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts.	New Brunswick	W. H. S. Demarest	Agr., civil engin. and mech., chem., elect., biol., clay working and ceramics (B. S.), Lat. sci. (B. Litt.).	Clay working and ceramics (2 yrs.), general agr., dairy farming, fruit growing, and market gardening (12 weeks each).
New Mexico	New Mexico College of Agriculture and Mechanic Arts.	Agricultural College.	Luther Foster, M. S. A.	Agr., mech. engin., domestic sci., general or sci. (B. S.).	Agr. and hort. (2 yrs.), pract. mech. (2 yrs.), prep. (2 yrs.), sten. (1 yr.), Engl.-Span. sten. (1 yr.), business (1 yr.).
New York	New York State College of Agriculture at Cornell University.	Ithaca	J. G. Schurman, A. M., D. Sc., LL. D.	Arts (A. B.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr. (B. S. A.), med. (M. D.), vet. sci. (D. V. M.).	Law (LL. B., 3 yrs.), special lect. courses in general agr. and nature study (1 or 2 yrs.), agr., dairying, poultry husb., hort., home econ. (winter, 11 weeks), reading courses for farmers and farmers' wives, summer school for teachers, nature study correspondence, course for teachers.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	Raleigh	G. T. Winston, A. M., LL. D.	Agr. (B. Agr.), mech. engin., civil engin., elect. engin. mining engin., textile sci. and art (B. E.), indus. chem. (B. S.).	Agr., mech. arts, textile indus., applied electricity (2 yrs.), normal courses in el. agr. and nature study (1 and 2 yrs.), agr. and dairying, textile indus. (10 weeks), summer school for teachers.
	The Agricultural and Mechanical College for the Colored Race.	Greensboro	J. B. Dudley, A. M., LL. D.	Agr. (B. Agr.), mech. (B. S.)	Dairying (6 weeks).
North Dakota	North Dakota Agricultural College.	Agricultural College.	J. H. Worst, LL. D.	Agr., gen. sci., mech., pharm. chem. (B. S.).	Agr. (3 yrs.), steam engin., dairying, phar., domestic econ., nature study and el. agr. for teachers, prep. (2 yrs.), agr. (12 weeks), domestic econ. (spring term), stock and grain judging (10 days), corresp. course in el. agr.
Ohio	Ohio State University	Columbus	W. O. Thompson, A. M., D. D., LL. D.	Agr. (B. S. Agr.), hort. and forestry, domestic sci., chem., indus. arts, manual training, phar. (B. S.), arts (B. A.), archi., civil engin. (C. E.), clay working and ceramics, mining engin. (E. M.), elect. engin. (M. E., E. E.), mech. engin. (M. E.).	Agr. and hort., ceramics, domestic sci., indus. arts, mining, phar. (2 yrs.), dairying (2 terms), agr. (10 weeks), vet. med. (3 yrs., D. V. M.), law (LL. B.) (3 yrs.).

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Four-year courses and degrees.	Short courses.
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	A. C. Scott, A. M., LL. M.	Agr., general sci., mech. engin., civil engin., elect. engin., sci. and lit. (5 yrs., B. S.).	Agr. and domestic sci. (2 yrs.), business (1 yr.), mech. (20 weeks), agr. and dairying (winter, 10 weeks), summer school for teachers in nature study and el. agr. (11 weeks), stock judging and seed selection (1 week), agr. for rural teachers (spring term).
	Agricultural Normal University.	Langston	I. E. Page, M. A.	Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil archi. (B. M. E.).	Normal elementary (4 yrs.), college prep. (3 yrs.).
Oregon	Oregon State Agricultural College.	Corvallis	T. M. Gatch, M. A., Ph. D.	Agr., mech. engin., elect. engin., civil engin., mining engin., household sci., phar., lit. commerce, forestry (B. S.).	Mining, phar. (2 yrs.), dairying (8 weeks), agr. (10 days).
Pennsylvania	The Pennsylvania State College.	State College	J. A. Beaver, LL. D.	Clas. (B. A.), general sci., mod. lang. and lit., Lat. sci., philos., agr., biol., chem., civil engin., elect. engin., indus. chem., math., mech. engin., mines and mining, phys. (B. S.).	Agr., chem., mech., mining (2 yrs.), agr. (1 yr.), agr., mining (12 weeks), dairying and creamery (8 weeks), summer school (2 weeks), corresp. courses in agr.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	Howard Edwards, M. A., LL. D.	Agr., mech. engin., highway engin., chem., biol., elect. engin., general sci. (B. S.).	Agr. (2 yrs.), indus. (2 yrs.), prep. (2 yrs.), farm mech. (12 weeks), poultry school (12 weeks), farm practice (6 weeks).
South Carolina	Clemson Agricultural College of South Carolina.	Clemson College	P. H. Mell, M. E., Ph. D., LL. D.	Agr. and hort., agr. and animal husb., mech. and elect. engin., civil engin., metal. and geol., textile indus. (B. S.).	Textile indus. (2 yrs.), prep. (1 yr.).
	The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina.	Orangeburg	T. E. Miller, LL. D.	Regular (B. A.), mech. (B. S.), agr. (B. Agr.), normal (L. I.), prep. and normal (5 yrs.).	Model school, indus., music, art.
South Dakota	South Dakota Agricultural College.	Brookings	R. L. Slagle, A. M., Ph. D.	Agr., domestic sci., general sci., mech. engin., elect. engin., civil and agr. engin., hort., phar. (B. S.).	Normal (3 yrs.), agr. (2 yrs.), phar. (2 yrs., Ph. G.), agr. (6 weeks), hort., domestic sci., butter making, cheese making, steam engin. (12 weeks), sten. and typewriting, commercial sci., steam engin. (1 yr.), art (3 yrs.), music.
Tennessee	University of Tennessee.	Knoxville	Brown Ayres, Ph. D., LL. D.	Lit. (B. A.), sci., agr. sci., civil engin., mech. engin., elect. engin., mining engin., chem. engin., phar. chem. (B. S.), med. (M. D.).	Dental surgery (D. D. S.), agr., phar. chem. (Ph. C., 2 yrs.), law (LL. B.), prep. med. (2 yrs.), agr., animal husb., dairy husb., poultry husb., bee keeping, home econ., hort. (2 weeks each), summer school for teachers (6 weeks).

Texas	Agricultural and Mechanical College of Texas.	College Station	H. H. Harrington, LL. D.	Agr., textile engin., elect. engin., mech. engin., civil engin., archi. engin. (B. S.).	Stock farming, dairying, hort. (10 weeks).
	Prairie View State Normal and Industrial College.	Prairie View	E. L. Blackshear	Clas. and sci. (6 yrs., B. A.), normal, industrial.	Mech. arts, agr. and hort., and dairying.
Utah	Agricultural College of Utah.	Logan	W. J. Kerr D. Sc	Agr., domestic sci., commerce, civil engin., mech. engin., general sci. (B. S.)., manual training in domestic arts and mech. arts.	Agr., domestic sci., commerce (3 yrs.), prep. (2 yrs.), agr. (4 weeks), domestic arts, mech. arts, commerce (12 weeks), summer school for teachers (5 weeks).
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham, D. D., LL. D.	Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin., mech. engin., chem., agr., commerce and econ. (B. S.), med. (M. D.).	Agr. (1 or 2 yrs.).
Virginia	The Virginia Agricultural and Mechanical College and Polytechnic Institute.	Blacksburg	J. M. McBryde, Ph. D., LL. D.	Agr., hort., applied chem., general sci., civil engin., mech. engin., elect. engin., metal. and metallography, applied geol., prep. med. and vet. sci. (B. S.).	Agr., mech. (2 yrs.), summer school (6 weeks).
	Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell, D. D., LL. D.	Academic (4 yrs.)	Trade (3 yrs.). Postgradute: Agr., trades (3 yrs.), normal (2 yrs.), business (1 yr.).
Washington	The State College of Washington.	Pullman	E. A. Bryan, M. A., LL. D.	Math. and civil engin., domestic econ., phar., chem., bot. and zool., agr., hort., vet. sci., econ. sci. and hist., elect. engin., mech. engin., mining engin. (B. S., B. A.), geol., Engl. lang. and lit., modern lang., Latin (B. A.).	Supplementary courses in phys., geol. and mineralogy, Lat., phar. (2 yrs.), agr., vet. sci. (D. V. S.), prep. (3 yrs.), business (1 and 2 yrs.), artisans (1 yr.), dairying (8 weeks), hort. (4 weeks), music (3 yrs.), summer science school for teachers (6 weeks).
West Virginia	West Virginia University.	Morgantown	D. B. Purinton, Ph. D., LL. D.	General culture (B. A., B. S.), mech. and elect. engin. (B. S., M. E.), civil engin. (B. S., C. E.), mining engin. (B. S., E. M.), agr. (B. S. Agr.), law (LL. B.), music.	Agr., mech. and elect., law, commercial (2 yrs.), agr. (1 yr.), prep. (1 yr.), agr., hort., vet. sci., stock breeding and feeding, dairying, poultry culture (12 weeks), nature study (6 weeks).
	The West Virginia Colored Institute.	Institute	J. McH. Jones, A. M.	Academic, normal, agr	Sewing (2 yrs.), dressmaking (2 yrs.), commercial (2 yrs.), mech. (3 yrs.), printing (3 yrs.).
Wisconsin	University of Wisconsin.	Madison	C. R. Van Hise, Ph. D.	Sci., home econ., commerce (B. A.), normal (B. Ph.), agr. (B. S. Agr.), civil engin., sanitary engin., mech. engin., elect. engin., general engin., applied electrochem., phar. (B. S.), music.	Law (LL. B.), phar. (Ph. G., 2 yrs.), music, agr. (2 winter courses, 14 weeks each), dairy school (12 weeks), creamery (summer), farmers' course (2 weeks), summer school (6 weeks).
Wyoming	University of Wyoming.	Laramie	F. M. Tisdel, Ph. D.	Clas., lit. sci., education (B. A.), normal (B. Ped.), polit. sci., hist., general sci., agr., mech. engin., mining engin., irrig. engin. (B. S.), music, commerce.	Prep. (3 yrs.), prep. med., prep. law (2 yrs.), agr. (1 to 2 yrs.), agr. (12 weeks), school of mines (6 weeks), animal husb. (winter), domestic sci., irrig., live-stock management and judgment (2 weeks), corresp. courses.

TABLE 2.—*General statistics*

State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty. College of agriculture and mechanic arts. Preparatory classes.	Faculty. College of agriculture and mechanic arts. Collegiate and special classes.	Faculty. College of agriculture and mechanic arts. Total.	Faculty. Other departments.	Experiment station officers.
Alabama (Auburn)	1872	1872	4	41	a 43	....	17
Alabama (Normal)	1875	1882	8	13	21	6	....
Arizona	1891	1891	8	18	26	....	10
Arkansas (Fayetteville)	1872	1872	7	14	21	21	12
Arkansas (Pine Bluff)	1875	....	9	9	a 9	....	....
California	1868	1868	....	66	66	166	40
Colorado	1877	1878	14	40	a 45	....	21
Connecticut	1881	1881	....	23	23	....	13
Delaware (Newark)	1870	1870	....	20	20	....	7
Delaware (Dover)	1892	1892	6	6	a 8	....	....
Florida (Gainesville)	1884	1884	....	27	27	109	11
Florida (Tallahassee)	1887	1890	....	....	....	22	....
Georgia (Athens)	1872	1872	....	23	23	....	....
Georgia (Savannah)	1890	1890	12	4	a 14	....	....
Idaho	1892	1892	4	22	26	3	8
Illinois	1867	1868	11	231	242	166	38
Indiana	1874	1874	....	120	120	112	24
Iowa	1869	1869	....	....	102	....	25
Kansas	1863	1874	5	63	68	13	20
Kentucky (Lexington)	1865	1880	4	31	35	3	18
Kentucky (Frankfort)	1887	1892	3	11	14	1	....
Louisiana (Baton Rouge)	1877	1887	7	30	a 32	....	26
Louisiana (New Orleans)	1880	1890	9	8	17	....	....
Maine	1865	1868	8	55	a 55	14	15
Maryland (College Park)	1859	1859	2	20	22	....	23
Maryland (Princess Anne)	....	....	10	....	10	....	....
Massachusetts (Amherst)	1867	1867	....	32	32	....	23
Massachusetts (Boston)	1865	....	....	248	248	....	....
Michigan	1855	1855	....	....	81	....	15
Minnesota	1869	1869	27	27	54	119	20
Mississippi (Agricultural College)	1880	1880	6	28	34	9	19
Mississippi (Lorman)	1871	1878	11	5	16	....	....
Missouri (Columbia)	1870	1870	....	78	78	....	31
Missouri (Jefferson City)	1866	1866	18	7	a 20	....	....
Montana	1893	1893	12	29	a 30	....	13
Nebraska	1869	1869	....	43	43	156	25
Nevada	1873	1888	6	20	26	....	9
New Hampshire	1866	1886	....	24	24	....	14
New Jersey	1864	1865	11	27	a 37	3	10
New Mexico	1889	1890	4	26	a 30	....	13
New York	1865	1865	....	95	95	372	23
North Carolina (Raleigh)	1889	1889	....	40	40	....	17
North Carolina (Greensboro)	1891	1891	....	11	11	....	....
North Dakota	1890	1890	24	26	50	....	17
Ohio	1870	1873	....	123	123	26	....
Oklahoma (Stillwater)	1891	1892	....	31	31	....	12
Oklahoma (Langston)	1897	1899	2	6	8	7	....
Oregon	1868	1888	....	36	36	....	13
Pennsylvania	1855	1859	5	65	a 65	....	20
Rhode Island	1888	1890	11	24	a 24	....	16
South Carolina (Clemson College)	1889	1893	2	41	43	....	20
South Carolina (Orangeburg)	1896	1896	12	6	18	8	....
South Dakota	1881	1884	15	32	a 34	....	13
Tennessee	1794	1869	....	53	53	35	15
Texas (College Station)	1871	1871	....	46	46	....	19
Texas (Prairie View)	....	....	....	5	5	10	....
Utah	1888	1889	29	30	59	....	21
Vermont	1865	1885	....	38	38	34	13
Virginia (Blacksburg)	1872	1872	....	56	56	....	23
Virginia (Hampton)	1868	1890	113	....	113	12	....
Washington	1892	1892	13	57	70	....	16
West Virginia (Morgantown)	1867	1867	7	38	45	19	13
West Virginia (Institute)	1891	1892	7	16	a 21	2	....
Wisconsin	1848	1866	....	75	75	217	31
Wyoming	1887	1891	14	15	a 19	2	10
Total	....	....	480	2,454	3,020	1,667	832

a Total, counting none twice.
b Including all departments of the university.

of land-grant colleges, 1906.

Graduates.								
In 1905–6.								
Number.	Average age.		Total number since organization.	Number of volumes in library.	Number of acres allotted to State under act of 1862.	Number of acres of land grant of 1862 still unsold.	Number of acres in farm and grounds.	Rate of interest on land-grant fund of 1862.
	Y.	*M.*						*Per cent.*
57	20		887	22,890	240,000	....	325	8
147	20		1,146	....	....	....	182	....
9	24		50	24,500	....	....	465	....
52	21		442	17,000	150,000	....	155	8
9	21		183	5,000	....	....	20	....
413	23		4,442	310,000	150,000	1,402	411	6
26	21		285	35,080	90,000	40,000	600	6
15	20	4	249	11,520	180,000	....	300	5
18	21	6	384	23,600	90,000	....	16	6
10	22		39	1,300	....	....	97	....
9	....		107	8,000	90,000	....	355	6
14	25	6	101	....	....	....	160	....
12	21		420	51,000	270,000	....	787	7
8	25		166	800	....	....	86	....
30	23		156	1,650	90,000	89,040	158	....
334	23	6	b 4,584	123,476	480,000	40	665	5
215	24	10	2,424	20,000	390,000	....	189	5
132	....		....	25,500	204,000	....	1,041	6, 7, 8
96	23	6	1,216	30,768	82,313	....	430	5, 5½, 6, 7
64	21	6	538	21,030	330,000	....	258	6
12	22		148	2,924	....	....	310	....
36	21	6	416	24,500	210,000	....	664	4, 5
34	18	4	359	4,283	....	....	104	....
74	23	8	1,050	39,000	210,000	....	373	5
13	21		....	9,000	210,000	....	286	5, 6
19	21		46	700	....	....	116	....
28	23	4	690	26,944	360,000	....	404	5
277	22	9	3,425	91,762	....	....	....	....
74	19		1,175	31,631	235,673	52,046	684	7
499	....		b 5,957	127,927	94,000	40	300	3, 4, 5
33	21		425	25,500	207,920	....	2,000	6
14	22		171	2,700	....	....	300	5
70	....		2,654	75,000	277,016	47,107	722	5
14	24		372	7,000	....	....	45	....
7	21	4	50	18,117	90,000	88,337	220	....
241	22		b 2,650	83,891	90,000	....	332	4½, 6
25	....		295	44,680	90,000	2,200	73	4
17	22	6	302	15,643	150,000	....	343	6
37	22	5	609	55,485	210,000	....	140	5
11	22	1	64	21,500	....	....	293	....
605	23		b 8,699	375,585	989,920	....	498	5
53	23	4	304	7,500	270,000	....	674	6
7	23		56	2,700	....	....	127	....
7	23	3	51	10,250	130,000	67,300	640	....
216	23		2,157	75,709	630,000	....	439	6
17	22	6	143	30,797	....	....	1,000	....
3	25		9	1,225	....	....	160	....
42	....		593	4,500	90,000	4,200	210	6
86	23	10	905	23,635	780,000	....	400	6
8	21		116	18,974	120,000	....	178	3
60	21	10	396	15,488	180,000	....	1,136	6
54	18		383	1,390	....	....	130	....
25	22		304	19,850	160,000	156,202	560	....
34	20	10	....	41,000	300,000	....	272	6
46	21		580	13,482	180,000	....	2,416	6, 7
58	25		440	1,300	....	....	1,500	....
3	23		134	27,736	200,000	70,827	116	....
55	23	6	3,874	105,465	150,000	....	140	6
78	21	7	661	9,600	300,000	....	410	6
46	23		1,379	20,636	....	....	755	....
43	24		244	15,000	90,000	89,000	250	....
37	23		1,019	21,000	150,000	....	130	6
13	19		143	3,662	....	....	70	....
414	23		b 5,717	146,000	240,000	312	500	4
5	23		138	30,857	90,000	90,000	416	....
5,220	22	3	67,122	2,464,642	10,320,842	798,053	27,536	....

TABLE 3.—*Students, by classes and*

PART 1.—WHITE STUDENTS.

State or Territory.	By classes.					
	Preparatory.	Collegiate.	Short or special.	Post graduate.	Other departments.	Total.
Alabama	78	479		22		579
Arizona	163	44	15	4		226
Arkansas	548	438	72	13	457	1,528
California		926	37	28	[a] 3,182	[b] 4,170
Colorado	190	193	119	2		[b] 502
Connecticut		68	60			128
Delaware		112	6	1		119
Florida	51	62	15	8		136
Georgia		205	19	3		227
Idaho	108	204		1		[b] 310
Illinois	327	2,205		123	[f] 1,453	[b] 4,074
Indiana		1,456	102	31	440	2,029
Iowa	256	1,075	737		71	[b] 2,199
Kansas	598	842	282	20		[b] 1,690
Kentucky	114	409	4	28	258	813
Louisiana	120	318	20	6		464
Maine		448	94	12	82	[b] 611
Maryland	33	129	22	2		186
Massachusetts		218	44	8		270
Massachusetts (Boston)		1,440		26		1,466
Michigan	134	634	179	3		950
Minnesota	[g] 555	430	182		2,751	3,950
Mississippi	298	497	23	6		824
Missouri		839	139	49	1,045	[i] 2,072
Montana	61	109	74		118	362
Nebraska	[g] 393	547			1,974	2,914
Nevada	62	123	47		37	269
New Hampshire		143	46	2		191
New Jersey	158	171	8	3	61	401
New Mexico	125	55	35	2		217
New York		1,326	248		[j] 2,754	4,328
North Carolina		346	142	6		494
North Dakota	271	94	453	6	[k] 107	931
Ohio		927	164	6	917	2,014
Oklahoma	[g] 102	266	499		39	[b] 901
Oregon	110	492	115	18		735
Pennsylvania	46	682	71	3	[k] 2,500	3,302
Rhode Island	46	65	24			[b] 131
South Carolina	103	542	7			652
South Dakota	269	166	126	10		571
Tennessee		348	86	4	257	695
Texas		361	48	2		411
Utah	97	136	419	11		663
Vermont		329	23	2	169	523
Virginia		570	29	20		619
Washington	[n] 445	354	201	9	70	1,079
West Virginia		90	84		944	1,118
Wisconsin		897	485	14	2,175	3,571
Wyoming	29	13	90	3	177	[b] 304
Total	5,890	22,823	5,695	517	22,038	56,919

[a] Including 798 students in 1905 summer session.
[b] Total, counting none twice.
[c] Including horticulture.
[d] Including electrical engineering.
[e] Including horticulture and dairying.
[f] Including 423 students in 1905 summer session.
[g] School of agriculture.
[h] Including civil, electrical, and mining engineering.
[i] Including 396 students in 1905 summer session.
[j] Including 619 students in 1905 summer session.
[k] Correspondence course.
[l] Including agriculture, horticulture, and veterinary science.
[m] Including mining engineering.
[n] Including school of agriculture.

courses, at land-grant colleges in 1906.

PART 1.—WHITE STUDENTS.

By courses.													
Four-year.									Shorter.				
Agriculture.	Horticulture.	Household economy.	Mechanical engineering.	Civil engineering.	Electrical engineering.	Mining engineering.	Chemical engineering.	Architecture.	Agriculture.	Horticulture.	Dairying.	Veterinary science.	Military tactics.
37	19		83	37	86	27	36					28	496
			2	8		15							
32	41		48	90	84	29	72		25	36	30	20	503
c 80			d 227	174		227	45	16	37				916
70	3	49	29	41				1	119				295
53	5	3	1						10	4	10	10	72
2			14	39	27				7			9	105
3			7	11	6		7						108
18				32	30				e 19				224
2	2	60		9	28	46							154
139		62	221	323	233		38	91	e 228			177	1,170
73		16	439	374	450				c 84		21		880
169	18	93	94	224	192	35			631		73	55	580
178		229	57		202			28	c 118		28	28	350
22		44	153	87		8			4				285
25			22	55	30		51		2			16	336
20			46	132	99		1		21				191
28	1		35	27			2		14	1	1	25	150
218										2	42		262
			149	134	100	54	29	44					220
150		92	291						94	13	70		590
50		3	99	113	168	121			178		87		493
162			h 189						1				728
117			42	159	163	203	14		44	18	7		218
9		8	3	17	23				30				
20			32	89	101	6	3		350				348
1			25	6		38							111
13			5		3				32		10		144
7				79	35								165
8		9	23										119
128			1,077	425				81	248			88	600
56			51	87	70	1	18		52		23		400
25		4	20						212	15	49	104	225
121	17	35	73	128	139	48	26	10	79		23	117	1,065
18			d 46						l 420				
66		65	138		21	41			28				523
31			119	136	203	102	16		38	1	30		500
4			1		6				24				70
222			m 107	47	107				2				649
13	2	21	7	11	36				43		6		220
26		36	8	14	23	1	2		42	13	13	5	236
c 95			49	100	83			10	e 12				411
24		22		27					84	15	21	45	238
44			21	57	38							22	142
43	15		115	180	186				11			11	599
30	9	24	26	47	35	14			90	43	13	21	425
4			60	70					38			7	225
119		51	94	140	159	40	17		322		163	33	410
4			3	1		5			90				221
2,779	132	926	4,351	3,730	3,166	1,061	377	281	3,883	161	720	821	17,372

TABLE 3.—*Students, by classes and courses,*

PART 2.—NEGRO STUDENTS.

State or Territory.	By classes.					By courses.		
	Preparatory.	Collegiate.	Short or special.	Other departments.	Total.	Agriculture.	Carpentry.	Machine shop work.
Alabama (Normal)	144	8	88	238	478	173	29	35
Arkansas (Pine Bluff)	70	180	......	......	250	......	60	18
Delaware (Dover)	82	51	......	......	133	30	30	8
Florida (Tallahassee)	......	......	......	280	280	124	11	......
Georgia (Savannah)	362	12	......	......	374	4	31	......
Kentucky (Frankfort)	119	83	......	......	202	19	41	5
Louisiana (New Orleans)	351	2	......	......	353	45	56	56
Maryland (Princess Anne)	144	......	......	......	144	16	16	......
Mississippi (Lorman)	437	92	......	......	529	100	75	......
Missouri (Jefferson City)	36	......	......	375	411	36	41	7
North Carolina (Greensboro)	......	170	2	......	172	162	22	4
Oklahoma (Langston)	296	4	19	15	334	55	28	19
South Carolina (Orangeburg)	633	59	......	......	692	20	37	42
Texas (Prairie View)	412	......	......	......	412	98	45	......
Virginia (Hampton)	1,362	21	187	......	1,570	908	56	15
West Virginia (Institute)	96	......	14	108	218	8	21	2
Total	4,544	682	310	1,016	6,552	1,798	599	211

at land-grant colleges in 1906—Continued.

PART 2.—NEGRO STUDENTS.

By courses—Continued.															
Blacksmithing.	Shoemaking.	Broom making.	Wheelwrighting.	Bricklaying.	Painting.	Printing.	Harness making.	Tailoring.	Plastering.	Sewing.	Cooking.	Laundering.	Nursing.	Millinery.	Military tactics.
32	28	......	32	36	20	30	......	......	......	78	26	20	36	65	201
40	......	......	......	......	......	......	......	......	......	110	......	10	......	......	110
5	......	......	......	......	......	2	......	......	......	25	20	16	......	......	60
12	......	......	7	......	7	5	......	19	......	112	110	110	11	19	104
33	25	......	10	51	10	......	1	43	20	68	......	......	......	......	227
......	......	......	......	......	......	20	......	......	......	68	17	130	......	......	87
......	......	......	......	......	10	10	......	......	......	214	......	......	......	20	......
7	......	......	2	......	......	8	......	......	......	71	48	9	......	......	48
50	20	......	18	4	25	......	20	......	......	75	50	12	10	......	......
8	......	......	......	......	......	5	......	......	......	110	86	140	......	17	......
24	......	15	2	42	22	......	......	......	......	......	......	......	......	......	......
26	......	......	......	......	......	......	......	......	......	130	30	......	......	......	......
5	7	......	5	75	6	......	7	20	75	329	......	......	26	......	363
20	......	......	3	......	......	......	......	......	......	175	185	10	......	30	......
26	10	......	12	40	11	9	2	41	40	584	334	227	......	5	500
17	......	......	8	17	6	11	......	......	17	59	67	......	......	16	98
305	90	15	99	265	117	100	30	123	152	2,208	973	684	83	172	1,798

TABLE 4.—*Value of permanent funds and*

State or Territory.	Land-grant fund of 1862.	Other land-grant funds.	Other permanent funds.	Land grant of 1862 still unsold.	Farm and grounds owned by the institution.
Alabama (Auburn)	$253,500.00				$4,500.00
Alabama (Normal)					10,593.20
Arizona					25,640.00
Arkansas (Fayetteville)	130,000.00				12,000.00
Arkansas (Pine Bluff)					60,000.00
California	731,325.54	$154,712.27	$2,785,404.30	$5,807.60	
Colorado	109,411.18			125,000.00	125,000.00
Connecticut	135,000.00		60,000.00		30,000.00
Delaware (Newark)	83,000.00				10,000.00
Delaware (Dover)					6,000.00
Florida (Gainesville)	153,800.00	61,650.00			18,800.00
Florida (Tallahassee)					10,000.00
Georgia (Athens)	242,202.17				75,000.00
Georgia (Savannah)					8,600.00
Idaho	4,752.00	261,809.73		890,400.00	18,000.00
Illinois	635,026.03			400.00	175,000.00
Indiana	340,000.00				100,000.00
Iowa	683,000.00				100,000.00
Kansas	492,381.36				50,200.00
Kentucky (Lexington)	165,000.00				437,393.00
Kentucky (Frankfort)					25,100.00
Louisiana (Baton Rouge)	182,313.00	136,000.00			151,040.00
Louisiana (New Orleans)					40,000.00
Maine	118,300.00		100,000.00		25,000.00
Maryland (College Park)	118,000.00				30,000.00
Maryland (Princess Anne)					3,200.00
Massachusetts (Amherst)	219,000.00		142,000.00		44,350.00
Massachusetts (Boston)					
Michigan	973,336.49			65,057.50	48,137.50
Minnesota	570,747.59	796,891.38		240.00	550,000.00
Mississippi (Agr'l College)	98,575.00	141,212.55			63,500.00
Mississippi (Lorman)	113,575.00	96,296.00			35,000.00
Missouri (Columbia)	349,881.19	220,000.00	668,958.23	60,000.00	265,206.00
Missouri (Jefferson City)					8,000.00
Montana	14,357.90	25,157.51		299,541.00	31,000.00
Nebraska	433,646.31	159,757.30			325,000.00
Nevada	99,351.54	48,560.20	1,000.00		125,000.00
New Hampshire	80,000.00		70,000.00		20,500.00
New Jersey	116,000.00		550,000.00		142,000.00
New Mexico					17,500.00
New York	688,576.12		7,151,298.30		429,077.98
North Carolina (Raleigh)	125,000.00				60,000.00
North Carolina (Greensboro)					25,200.00
North Dakota	762,600.00			773,950.00	32,000.00
Ohio	524,176.58	69,930.53	167,935.63		1,540,000.00
Oklahoma (Stillwater)		500,000.00			30,000.00
Oklahoma (Langston)		2,827.18			7,000.00
Oregon	193,778.00			5,000.00	37,000.00
Pennsylvania	427,290.50				40,000.00
Rhode Island	50,000.00				14,855.00
South Carolina (Clemson College)	95,900.00		58,539.39		42,470.00
South Carolina (Orangeburg)	95,900.00				40,000.00
South Dakota	2,464.84			800,000.00	60,000.00
Tennessee	400,000.00				285,475.00
Texas (College Station)	209,000.00				50,000.00
Texas (Prairie View)					15,000.00
Utah	183,442.77				17,400.00
Vermont	135,500.00		581,951.87		37,000.00
Virginia (Blacksburg)	344,312.00				31,000.00
Virginia (Hampton)	176,156.00		1,428,758.00		57,000.00
Washington	2,000.00	1,025,000.00		890,000.00	20,000.00
West Virginia (Morgantown)	114,169.00		1,600.00		225,000.00
West Virginia (Institute)					11,500.00
Wisconsin	303,359.61	288,263.95	62,500.00	340.00	1,500,000.00
Wyoming	21,450.57			90,000.00	40,000.00
Total	12,500,558.29	3,988,068.60	13,829,945.72	4,005,736.10	7,873,237.68

a Including farm and grounds.
b Including all other equipment.
c Including value of land on which university buildings are located.

equipment of land-grant colleges, 1906.

Buildings.	Apparatus.	Machinery.	Libraries.	Live stock.	Miscellaneous equipment.	Total.
$153,700.00	$20,794.00	$23,488.00	$39,200.00	$2,500.00	$18,000.00	$515,682.00
55,000.00	6,960.30	3,441.35	12,000.00	641.75	....	88,636.60
152,708.89	28,522.08	18,881.04	20,414.69	1,270.00	....	247,436.70
400,000.00	67,000.00	36,000.00	18,000.00	3,000.00	....	666,000.00
28,000.00	600.00	15,000.00	2,500.00	....	1,800.00	107,900.00
a 3,947,017.74	....	....	....	....	....	7,624,267.45
190,251.00	54,500.00	19,516.60	31,247.90	11,063.00	23,000.00	688,989.68
175,000.00	13,700.00	7,500.00	20,000.00	10,000.00	21,700.00	472,900.00
145,000.00	51,500.00	22,000.00	22,900.00	200.00	3,000.00	337,600.00
26,000.00	1,000.00	800.00	300.00	1,000.00	500.00	35,600.00
150,000.00	....	....	....	....	b 55,000.00	439,250.00
25,200.00	7,384.59	1,754.87	....	829.50	....	45,168.96
c 550,000.00	35,000.00	....	40,000.00	1,500.00	....	943,702.17
32,433.04	3,144.00	200.00	400.00	415.00	....	45,192.04
120,000.00	10,842.81	10,349.65	2,200.00	5,320.00	6,823.82	1,330,498.01
1,500,000.00	230,000.00	140,000.00	140,000.00	40,000.00	150,000.00	3,010,426.03
680,000.00	....	d 210,000.00	24,000.00	7,500.00	25,000.00	1,386,500.00
1,200,000.00	122,500.00	30,000.00	75,000.00	22,500.00	75,000.00	2,308,000.00
422,579.45	47,552.26	39,729.37	52,554.10	15,800.00	130,154.04	1,250,950.58
262,859.00	51,707.00	26,708.00	13,911.00	3,054.00	423,326.00	1,383,958.00
40,000.00	300.00	2,700.00	2,000.00	2,500.00	1,300.00	73,900.00
427,700.00	19,683.56	16,230.38	29,653.98	1,390.00	27,806.65	991,817.57
47,760.82	3,644.31	4,415.10	3,990.00	1,100.00	7,551.10	108,461.33
325,000.00	30,000.00	17,500.00	32,000.00	4,700.00	13,000.00	665,500.00
170,000.00	....	d 50,000.00	6,500.00	....	....	374,500.00
12,800.00	....	....	....	1,000.00	e 1,900.00	18,900.00
252,775.00	8,000.00	....	27,000.00	9,816.00	124,556.61	827,497.61
882,376.16	....	d 382,500.00	145,189.60	....	....	1,410,065.76
471,613.00	42,032.47	37,280.00	48,921.83	11,756.50	....	1,698,115.29
1,300,000.00	120,000.00	90,000.00	98,000.00	....	20,000.00	3,545,878.97
364,391.00	23,287.22	120,896.37	22,597.17	24,405.00	72,738.64	931,602.95
155,000.00	1,200.00	....	4,500.00	4,000.00	3,000.00	412,571.00
1,000,000.00	140,000.00	26,000.00	130,000.00	8,000.00	60,000.00	2,928,045.42
125,000.00	1,000.00	6,000.00	2,500.00	200.00	100.00	142,800.00
123,500.00	46,800.00	15,500.00	17,400.00	3,760.00	21,500.00	598,516.41
670,000.00	f 125,000.00	....	150,000.00	18,800.00	120,000.00	2,002,203.61
174,200.50	21,260.10	15,460.74	20,625.20	2,187.95	42,000.00	549,646.23
238,000.00	26,000.00	6,700.00	15,000.00	3,900.00	16,000.00	476,100.00
488,000.00	35,000.00	....	51,000.00	....	80,000.00	1,462,000.00
53,000.00	19,750.00	28,000.00	17,000.00	2,250.00	8,000.00	145,500.00
2,946,007.83	....	....	653,221.00	....	957,862.41	12,826,043.64
265,050.00	15,400.00	50,000.00	8,006.89	1,500.00	15,000.00	539,956.89
65,000.00	9,000.00	7,247.96	1,580.85	2,902.50	2,676.25	113,607.56
280,393.03	17,802.85	16,262.62	19,297.64	8,098.56	6,241.07	1,916,645.77
1,210,000.00	310,000.00	100,000.00	200,000.00	13,000.00	....	4,135,042.74
123,074.75	49,831.09	32,644.67	23,440.38	12,829.00	22,421.00	794,240.89
56,100.35	2,200.00	9,969.25	2,150.00	1,135.00	3,000.00	84,381.78
160,000.00	5,000.00	27,000.00	....	....	....	427,778.00
1,272,500.00	....	....	35,000.00	....	e 60,000.00	1,834,790.50
130,139.90	....	....	18,488.71	....	106,258.57	319,742.18
418,025.87	22,003.00	106,661.00	24,832.00	12,123.00	....	780,554.26
85,000.00	3,600.00	7,150.00	1,700.00	2,200.00	2,300.00	237,850.00
225,000.00	17,000.00	15,000.00	5,500.00	10,000.00	3,500.00	1,138,464.84
214,072.88	58,058.90	54,481.76	15,707.42	4,624.50	15,500.07	1,047,920.53
500,000.00	17,000.00	52,000.00	15,242.00	11,000.00	30,000.00	884,242.00
91,000.00	1,000.00	3,500.00	1,200.00	2,000.00	1,000.00	114,700.00
280,761.83	27,939.82	23,863.50	12,074.35	6,502.37	28,952.89	580,937.53
810,000.00	43,000.00	21,500.00	103,000.00	3,750.00	167,500.00	1,903,201.87
390,065.00	....	d 166,827.00	5,877.00	....	....	938,081.00
650,000.00	....	....	8,500.00	15,862.00	170,000.00	2,506,276.00
265,000.00	335,000.00	45,500.00	25,000.00	6,000.00	17,500.00	2,631,000.00
475,000.00	14,000.00	32,000.00	43,500.00	1,500.00	50,000.00	956,769.00
93,100.00	2,949.00	13,200.00	3,800.00	1,705.00	....	126,254.00
1,595,300.00	....	587,068.48	224,511.60	21,247.00	....	4,582,590.64
185,000.00	65,890.52	34,638.35	29,478.95	5,575.50	10,000.00	482,033.89
30,322,457.04	2,432,339.88	2,831,046.06	2,819,614.26	369,913.13	3,222,469.12	84,195,385.88

d Including apparatus.
e Including apparatus and machinery.
f Including machinery.

TABLE 5.—*Revenue of land-grant colleges*

State or Territory.	Federal aid.			State aid.
	Interest on land grant of 1862.	Interest on other land grants.	Appropriation act of 1890.	Interest on endowment or regular appropriation.
Alabama (Auburn)	$20,280.00		$13,725.00	
Alabama (Normal)			11,275.00	
Arizona			25,000.00	
Arkansas (Fayetteville)	3,900.00		18,181.82	
Arkansas (Pine Bluff)			6,818.18	
California	43,806.40	$9,267.26	25,000.00	$44,925.00
Colorado	31,107.00		25,000.00	
Connecticut	6,755.50		25,000.00	
Delaware (Newark)	4,980.00		20,000.00	
Delaware (Dover)			5,000.00	
Florida (Gainesville)	7,710.00	2,981.25	12,500.00	
Florida (Tallahassee)			12,500.00	
Georgia (Athens)	16,954.14		16,666.67	
Georgia (Savannah)			8,333.33	
Idaho		18,000.00	25,000.00	
Illinois	33,072.05		25,000.00	
Indiana	17,000.00		25,000.00	
Iowa	34,170.40		25,000.00	
Kansas	31,275.51		25,000.00	
Kentucky (Lexington)	8,644.50		21,375.00	
Kentucky (Frankfort)	1,255.50		3,625.00	
Louisiana (Baton Rouge)	9,115.69	5,440.00	13,158.62	
Louisiana (New Orleans)			11,841.38	
Maine	5,915.00		25,000.00	
Maryland (College Park)	5,817.18		20,000.00	
Maryland (Princess Anne)			5,000.00	
Massachusetts (Amherst)	7,300.00		16,666.66	3,313.32
Massachusetts (Boston)	4,191.96		8,333.34	
Michigan	70,286.56		25,000.00	
Minnesota	23,966.52		25,000.00	33,462.15
Mississippi (Agricultural College)	5,914.50	8,472.75	12,339.20	
Mississippi (Lorman)	6,814.50	5,777.77	12,660.80	
Missouri (Columbia)	17,494.06	12,320.00	23,437.50	33,297.90
Missouri (Jefferson City)			1,562.50	
Montana	7,000.00		25,000.00	
Nebraska	30,000.00	10,000.00	25,000.00	
Nevada	4,600.00		25,000.00	
New Hampshire	4,800.00		25,000.00	
New Jersey	5,800.00		25,000.00	
New Mexico		1,498.02	25,000.00	
New York	34,428.80		25,000.00	
North Carolina (Raleigh)	7,500.00		16,750.00	
North Carolina (Greensboro)			8,250.00	
North Dakota	35,616.10		25,000.00	
Ohio	31,450.59	4,195.83	25,000.00	
Oklahoma (Stillwater)		14,303.87	22,500.00	
Oklahoma (Langston)			2,500.00	
Oregon	12,293.05		25,000.00	
Pennsylvania	25,637.43		25,000.00	5,382.57
Rhode Island	2,500.00		25,000.00	
South Carolina (Clemson College)	5,754.00		12,500.00	
South Carolina (Orangeburg)	5,754.00		12,500.00	
South Dakota	14,006.07		25,000.00	
Tennessee	23,960.00	250.00	25,000.00	
Texas (College Station)	14,280.00		18,750.00	
Texas (Prairie View)			6,250.00	
Utah	6,961.04		25,000.00	
Vermont	8,130.00		25,000.00	2,600.00
Virginia (Blacksburg)	20,658.00		16,666.67	
Virginia (Hampton)	10,329.36		8,333.33	
Washington	5,000.00		25,000.00	
West Virginia (Morgantown)	6,500.00		20,000.00	
West Virginia (Institute)			5,000.00	
Wisconsin	12,828.68	13,678.42	25,000.00	
Wyoming	5,239.25		25,000.00	
Total	758,753.34	106,185.17	1,200,000.00	122,980.94

for year ended June 30, 1906.

State aid—Continued.		Income from endowment other than Federal or State grants.	Fees and all other sources.			Total.	United States appropriations for experiment stations (acts of 1887 and 1906).
Appropriation for current expenses.	Appropriation for buildings or for other special purposes.		Tuition fees.	Incidental fees.	Miscellaneous.		
$29,600.00	$1,500.00		$1,180.00	$2,725.00	$5,179.00	$74,189.00	$20,000.00
4,000.00				350.00		15,625.00	
27,000.00	20,000.00		445.00	500.00	3,353.54	76,298.54	20,000.00
75,000.00	50,000.00			5,375.00	316.96	152,773.78	20,000.00
6,000.00			300.00			13,118.18	
342,832.40	132,584.01	$96,114.80	3,375.00	38,169.79	314,116.22	1,050,190.88	20,000.00
69,069.41	15,000.00				7,589.37	147,765.78	20,000.00
20,000.00	60,000 00				30,272.41	142,027.91	10,000.00
	7,500.00		900.00	3,100.00	1,669.86	38,149.86	20,000.00
	3,000.00				6,101.57	14,101.57	
12,263.03				964.59	853.04	37,271.91	20,000.00
3,500.00	5,500.00			500.00		22,000.00	
				192.50		33,813.31	
8,000.00						16,333.33	
17,000.00						60,000.00	20,000.00
350,000.00	442,035.00			a210,989.79	83,266.45	1,144,363.29	20,000.00
153,828.81	42,628.04		9,281.25	49,428.85	6,176.32	303,343.27	20,000.00
156,041.65	266,022.43		1,308.00	30,638.50	7,554.19	520,735.17	20,000.00
90,000.00	45,500.00		11,254.00			203,029.51	20,000.00
68,452.19			4,013.50	3,316.50	2,091.98	107,893.67	20,000.00
8,000.00	20,000.00			200.00	4,927.40	38,007.90	
15,000.00	22,500.00		1,380.00	2,234.50	7,967.27	76,796.08	20,000.00
10,000.00					255.75	22,097.13	
32,000.00		4,000.00	12,000.00	8,000.00		86,915.00	20,000.00
9,000.00	20,000.00		b22,855.92	2,651.66	11,551.67	91,876.43	20,000.00
			392.90	311.00	709.49	6,413.39	
40,250.00	51,650.00		398.00	1,434.08	5,816.28	126,828.34	19,617.70
25,000.00		76,274.46	320,585.55	12,877.43	24,584.55	471,847.29	
47,000.00	93,767.35		865.00	5,272.50	46,408.31	288,599.72	20,000.00
251,873.58	555,100.00		130,879.03		27,272.76	1,047,554.04	20,000.00
65,946.36	27,874.70		680.00	3,612.50	41,336.60	166,176.61	20,000.00
8,000.00	24,500.00					57,753.07	
205,500.00	191,822.16	100.00		17,688.00	55,117.08	556,776.70	20,000.00
27,200.00						28,762.50	
18,000.00			2,113.00	800.00	4,925.00	57,838.00	20,000.00
197,500.00	137,470.00	1,000.00	9,878.05	8,518.00	33,105.20	452,471.25	20,000.00
25,000.00	10,000.00	120.00	2,000.00		1,267.11	67,987.11	20,000.00
13,000.00	30,500.00	3,252.00	3,012.50	1,635.88	17,368.82	98,569.20	20,000.00
40,300.00	24,000.00	19,202.19			c12,770.74	127,072.93	20,000.00
13,152.51			1,467.10		5,503.71	46,621.34	20,000.00
75,000.00		367,205.72	310,616.61	78,692.25	318,316.94	1,209,260.32	18,000.00
25,000.00	5,000.00		13,513.35	7,475.29	7,259.23	82,497.87	20,000.00
7,500.00	3,750.00		166.14			19,666.14	
33,849.83				5,041.60	4,463.75	103,971.28	20,000.00
323,422.15	208,035.37	7,492.29	46,184.50		45,204.50	690,985.23	
25,572.74	101,100.97			1,431.00	22,624.09	187,532.67	20,000.00
28,971.82						31,471.82	
	25,000.00			1,271.26	4,459.13	68,023.44	20,000.00
85,960.17	39,018.00		855.00	20,890.07	49,176.40	251,919.64	20,000.00
15,000.00	25,300.00		500.00	1,000.00		69,300.00	20,000.00
158,354.03		3,512.36	2,956.33		41,016.35	224,093.07	20,000.00
6,300.00						24,554.00	
36,200.00	16,000.00		3,244.00	3,115.00	14,862.93	112,428.00	
	25,000.00	2,295.37	d15,775.51		10,858.32	103,139.20	20,000.00
73,085.00	15,000.00			2,055.00		123,170.00	20,000.00
17,500.00					24,500.00	48,250.00	
65,000.00	5,250.00		3,240.00	1,400.20	23,714.84	130,566.08	
6,000.00		26,041.99	d33,949.74		7,744.85	109,466.58	20,000.00
45,000.00	82,500.00			36,826.00		201,650.67	20,000.00
		66,673.31			140,640.37	225,976.37	
75,000.00	2,500.00		110.00	3,546.00	16,680.60	127,836.60	20,000.00
103,150.00	28,837.50				c20,718.00	179,205.50	20,000.00
23,775.00	5,900.00		199.00		546.30	35,420.30	
572,914.00	200,000.00	3,453.72	20,390.90	57,667.50	137,418.22	1,043,351.44	20,000.00
21,285.66	301.79	400.00	738.50	39.75	30.30	53,035.25	20,000.00
4,308,150.34	3,088,947.32	677,138.21	993,003.38	631,936.99	1,659,663.77	13,546,759.46	867,617.70

a Including tuition fees.
b Including board of students.
c Including tuition and incidental fees.
d Including incidental fees.

TABLE 6.—*Additions to equipment of land-grant colleges, 1906.*

State or Territory.	Permanent endowment.	Buildings.	Libraries.	Apparatus.	Machinery.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn)			$1,600.00	$2,743.00	$1,000.00			$5,343.00
Alabama (Normal)		$2,500.00				$265.00		2,765.00
Arizona		5,800.00	1,500.00	4,081.09	1,844.17	270.00		13,495.26
Arkansas (Fayetteville)		99,000.00	3,000.00	2,000.00	1,000.00	500.00	$500.00	106,000.00
Arkansas (Pine Bluff)								
California	$51,767.17	186,947.28	268,622.14	34,481.96				541,818.55
Colorado		9,402.00	3,449.97	2,500.00	1,275.12		2,000.00	18,627.09
Connecticut	60,000.00	65,824.79	304.15	642.09	273.65	137.60	15,135.62	142,317.90
Delaware (Newark)		15,000.00	900.00	650.00	400.00		700.00	17,650.00
Delaware (Dover)		5,000.00					815.00	5,815.00
Florida (Gainesville)							4,049.87	4,049.87
Florida (Tallahassee)		1,600.00	10,000.00	710.15	262.00	305.00		12,877.15
Georgia (Athens)			3,000.00	3,000.00		1,000.00	500.00	7,500.00
Georgia (Savannah)		2,288.30						2,288.30
Idaho	53,490.70	40,000.00	4,200.00	2,790.00	2,800.00	431.71	2,025.00	105,737.41
Illinois	11,316.50	100,000.00	15,000.00	30,000.00	40,000.00	10,000.00	20,000.00	226,316.50
Indiana		54,000.00	3,700.00	26,800.00	2,000.00	3,000.00	4,700.00	94,200.00
Iowa		257,160.77	1,500.00	[a]5,000.00				263,660.77
Kansas		32,000.00	1,800.00	3,050.00	1,135.00	765.00	3,200.00	41,950.00
Kentucky (Lexington)		778.80	1,067.78	3,171.77	868.10	225.00	1,374.68	7,486.13
Kentucky (Frankfort)			75.00	127.00		50.00		252.00
Louisiana (Baton Rouge)		750.00	1,127.58	5,771.15	2,236.45	1,240.00	2,253.72	13,378.90
Louisiana (New Orleans)			10.00					10.00
Maine		50,000.00	1,500.00	600.00	500.00	400.00	200.00	53,200.00
Maryland (College Park)			500.00	1,500.00				2,000.00
Maryland (Princess Anne)					204.13	5.00	44.61	253.74
Massachusetts (Amherst)		37,000.00	1,000.00	200.00		2,001.00		40,201.00
Massachusetts (Boston)								
Michigan	7,082.73	93,767.35	3,357.43	5,595.14	558.24			110,360.89
Minnesota		173,000.00	5,000.00		6,000.00	4,500.00		188,500.00
Mississippi (Agricultural College)		29,525.00	1,831.52	2,096.89	11,944.65	4,136.00	4,917.84	54,451.90
Mississippi (Lorman)		5,000.00				2,000.00		7,000.00
Missouri (Columbia)								
Missouri (Jefferson City)		2,500.00	2,000.00	300.00				4,800.00
Montana	2,207.00	2,800.00	1,200.00	3,000.00	2,000.00	1,750.00		12,957.00
Nebraska	135,932.61	50,000.00	5,000.00	8,000.00	2,000.00	3,500.00	2,000.00	206,432.61
Nevada		6,981.86	1,054.93	755.50	1,551.97	525.00	4,990.41	15,859.67
New Hampshire		25,000.00	1,200.00	2,314.39	242.09	184.15		28,940.63
New Jersey	37,130.40	646.37	2,783.22	1,741.96	8.48	40.00	586.96	42,937.39
New Mexico			1,000.00	750.00	750.00	600.00		3,100.00
New York	161,628.07	15,000.00	31,739.00				16,069.52	224,436.59
North Carolina (Raleigh)			850.92	400.00	5,000.00	1,500.00		7,750.92
North Carolina (Greensboro)		7,500.00	50.00		247.96	255.00		8,052.96
North Dakota		45,035.66	1,095.58	2,499.44	4,990.08	1,541.64	4,328.11	59,490.51
Ohio	66,204.55	45,000.00	15,000.00	10,000.00		5,000.00		141,204.55

Oklahoma (Stillwater)	500,000.00	17,500.00	1,029.59	5,100.00	6,000.00	3,100.00	1,000.00	533,729.59
Oklahoma (Langston)		18,000.00	150.00	350.00		450.00		18,950.00
Oregon			696.69	355.67	446.70	441.90	6,000.00	7,940.96
Pennsylvania		15,472.96	800.00					16,272.96
Rhode Island		5,000.00	1,480.00	350.00				6,830.00
South Carolina (Clemson College)		22,866.87	1,529.00	1,352.89	3,591.58			29,340.34
South Carolina (Orangeburg)				100.50	192.00			292.50
South Dakota			300.00	1,000.00	500.00	800.00	1,400.00	4,000.00
Tennessee		6,217.05	2,041.86	5,309.26	3,548.17	511.00	341.39	17,968.73
Texas (College Station)		5,000.00			[b]11,000.00		400.00	16,400.00
Texas (Prairie View)			250.00		500.00		500.00	1,250.00
Utah		4,498.30	1,424.35	2,939.82	3,863.50	2,002.37	5,185.01	19,913.35
Vermont	30,000.00		1,500.00	600.00	250.00	100.00	500.00	32,950.00
Virginia (Blacksburg)		59,363.00	950.00				[c]12,663.00	72,976.00
Virginia (Hampton)	98,325.00	57,000.00	1,300.00				4,200.00	160,825.00
Washington		5,000.00	800.00	[a]7,000.00			780.00	13,580.00
West Virginia (Morgantown)		7,750.00	3,500.00	1,500.00	12,000.00		4,087.50	28,837.50
West Virginia (Institute)		16,000.00	200.00	224.00	400.00		150.00	16,974.00
Wisconsin		38,642.63	36,370.47	[a]32,236.27		462.00	5,998.95	113,710.32
Wyoming			1,622.05	1,650.69	1,416.16	2,250.50		6,939.40
Total	1,215,084.73	1,745,118.99	452,963.23	227,340.63	134,800.20	56,244.87	133,597.19	3,965,149.84

[a] Including machinery.
[b] Including apparatus.
[c] Including apparatus, machinery, and live stock.

TABLE 7.—*Disbursements from the United States Treasury to the States and Territories of the appropriations in aid of colleges of agriculture and the mechanic arts under the act of Congress approved August 30, 1890.*(a)

State or Territory.	Year ending June 30—										
	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	b 1900.
Alabama	$15,000	$16,000	$17,000	$18,000	$19,000	$20,000	$21,000	$22,000	$23,000	$24,000	$25,000
Arizona	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Arkansas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
California	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Colorado	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Connecticut	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Delaware	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Florida	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	22,000	24,000	25,000
Georgia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Idaho				18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Illinois	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Indiana	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Iowa	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Kansas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Kentucky	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Louisiana	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Maine	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Maryland	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Massachusetts	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Michigan	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Minnesota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Mississippi	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Missouri	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Montana				18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Nebraska	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Nevada	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Hampshire	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Jersey	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Mexico	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New York	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
North Carolina	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
North Dakota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Ohio	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Oklahoma			17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Oregon	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Pennsylvania	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Rhode Island	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
South Carolina	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
South Dakota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Tennessee	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Texas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Utah	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000

Vermont	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Virginia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Washington	.....	.....	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
West Virginia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Wisconsin	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Wyoming	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Total	660,000	704,000	782,000	864,000	912,000	960,000	1,008,000	1,056,000	1,104,000	1,152,000	1,200,000

a From the annual statement of Commissioner of Education to the Secretary of the Interior, 1906.

b For each of the years ended June 30, 1901, 1902, 1903, 1904, 1905, 1906, and 1907 the sum of $25,000 was paid to each of the 48 States and Territories included in this tabular statement, the total amount disbursed for each of said years being $1,200,000.

STATISTICS OF AGRICUL

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Alabama (College)	Auburn	J. F. Duggar, M. S.	Feb. —, 1883	Feb. 24, 1888
Alabama (Canebrake)	Uniontown	J. M. Richeson,[a] M. S.	Jan. 1, 1886	Apr. 1, 1888
Alabama	Tuskegee Institute	G. W. Carver, M. S. Agr.	Feb. 15, 1897	
Arizona	Tucson	R. H. Forbes, M. S.		1889
Arkansas	Fayetteville	W. G. Vincenheller		1887
California	Berkeley	E. J. Wickson,[b] A. M.	1875	Mar. —, 1888
Colorado	Fort Collins	L. G. Carpenter, M. S.		Feb. 29, 1888
Connecticut (State)	New Haven	E. H. Jenkins, Ph. D.	Oct. 1, 1875	May 18, 1887
Connecticut (Storrs)	Storrs	L. A. Clinton, M. S.		do
Delaware	Newark	Harry Hayward, M. S. Agr.		Feb. 21, 1888
Florida	Gainesville	P. H. Rolfs, M. S.		1888
Georgia	Experiment	M. V. Calvin	Feb. 18, 1888	July 1, 1889
Idaho	Moscow	H. T. French, M. S.		Feb. 26, 1892
Illinois	Urbana	Eugene Davenport, M. Agr.		Mar. 21, 1888
Indiana	Lafayette	Arthur Goss, M. S., A. C.	1885	Jan. —, 1888
Iowa	Ames	C. F. Curtiss, M. S. A.		Feb. 17, 1888
Kansas	Manhattan	C. W. Burkett, M. S.		Feb. 8, 1888
Kentucky	Lexington	M. A. Scovell, M. S.	Sept. —, 1885	Apr. —, 1888
Louisiana (Sugar)	New Orleans	W. R. Dodson, A. B., B. S.	Sept. —, 1885	
Louisiana (State)	Baton Rouge	do	Apr. —, 1886	
Louisiana (North)	Calhoun	do	May —, 1887	

[a] Assistant director in charge.

[b] Acting director.

TURAL EXPERIMENT STATIONS.

statistics, 1906.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1905-6.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
17	13	8	4	106	14,000	Chemistry; botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; dairying.
2	......	....	1	29	2,000	Soil improvement; field experiments; horticulture; floriculture; plant breeding; diseases of plants and animals.
11	9	9	3	37	1,500	Field experiments; horticulture; plant breeding; diseases of plants; animal industry; poultry investigations; dairying.
10	2	3	7	87	6,000	Chemistry; botany; field experiments, improvement of ranges; horticulture, including date-palm culture; feeding and breeding experiments; irrigation.
12	7	7	5	274	14,150	Chemistry; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding and breeding experiments; entomology; nursery inspection; dairying; poultry experiments.
40	10	6	24	708	8,000	Chemistry; soils; bacteriology; fertilizer control; field crops; horticulture, including date culture, viticulture, and zymology; botany; meteorology; animal husbandry; entomology; dairying; poultry culture; drainage and irrigation; sylviculture; reclamation of alkali lands; animal and plant pathology; nutrition investigations.
21	14	15	18	438	8,000	Chemistry; meteorology; field experiments; horticulture; forestry; plant breeding; diseases of plants; animal husbandry; veterinary investigations; entomology; irrigation.
17	......	6	3	400	8,906	Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; plant selection and breeding; forestry; field experiments; entomology.
13	6	5	6	324	9,500	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; horticulture; feeding and breeding experiments; poultry experiments; dairying.
7	6	4	5	133	6,854	Chemistry; bacteriology; mycology; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; dairying.
11	10	....	6	181	4,500	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; veterinary science; entomology.
12	1	4	6	168	15,424	Chemistry; field experiments; bacteriology; horticulture; plant breeding; plant diseases; entomology; feeding experiments; dairying.
8	4	6	7	116	6,000	Chemistry; physics; botany; field experiments; horticulture; plant breeding and diseases; entomology; animal husbandry; irrigation.
38	20	22	19	440	33,000	Chemistry; soil physics; bacteriology; pot and field experiments; horticulture; forestry; plant breeding; animal husbandry; diseases of plants and animals; dairying.
24	11	15	8	334	15,192	Chemistry; soils; pot and field experiments; horticulture; plant breeding; breeding and feeding experiments; diseases of plants and animals; entomology; dairying.
25	17	17	5	174	20,000	Chemistry; botany; soils; field experiments; horticulture; plant breeding; forestry; diseases of plants; animal husbandry; poultry investigations; entomology; dairying; rural engineering; good roads investigations.
20	16	14	8	206	22,600	Chemistry; soils; horticulture; plant breeding; field experiments; feeding and digestion experiments; poultry experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers; irrigation.
18	......	3	11	1,606	10,500	Chemistry; soils; inspection of fertilizers, foods, feeding stuffs, seeds, orchards, and nurseries; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants; entomology; apiculture; dairying.
26	2	8	4	95	13,000	Chemistry; bacteriology; soils; field experiments; horticulture; sugar making; drainage; irrigation. Geology; botany; bacteriology; soils; inspection of fertilizers, foods, and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology. Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; poultry experiments; dairying.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Maine	Orono	C. D. Woods, Sc. D.	Mar. —, 1885	Oct. 1, 1887
Maryland	College Park	H. J. Patterson, B. S.	1888	Apr. —, 1888
Massachusetts	Amherst	W. P. Brooks, Ph. D.	[a] 1882	Mar. 2, 1888
Michigan	Agricultural College	C. D. Smith, M. S.		Feb. 26, 1888
Minnesota	St. Anthony Park	W. M. Liggett	Mar. 7, 1885	1888
Mississippi	Agricultural College	W. L. Hutchinson, M. S.		Jan. 27, 1888
Missouri (College)	Columbia	H. J. Waters, B. S. A.		Jan. —, 1888
Missouri (Fruit)	Mountain Grove	Paul Evans	Feb. 1, 1900	
Montana	Bozeman	F. B. Linfield, B. S. A.		July 1, 1893
Nebraska	Lincoln	E. A. Burnett, B. S.	Dec. 16, 1884	June 13, 1887
Nevada	Reno	J. E. Stubbs, M. A., D. D., LL. D.		Dec. —, 1887
New Hampshire	Durham	W. D. Gibbs, M. S.	1886	Aug. 4, 1887
New Jersey (State)	New Brunswick	E. B. Voorhees, D. Sc.	Mar. 10, 1880	
New Jersey (College)	do	do		Apr. 26, 1888
New Mexico	Agricultural College	Luther Foster, M. S. A		Dec. 14, 1889
New York (State)	Geneva	W. H. Jordan, D. Sc.	Mar. —, 1882	
New York (Cornell)	Ithaca	L. H. Bailey, M. S.	1879	Apr. —, 1888
North Carolina	Raleigh	B. W. Kilgore, M. S.	Mar. 12, 1877	Mar. 7, 1887

[a] In 1882 the State organized a station here and maintained it until June 18, 1895, when it was combined with the Hatch Station at the same place.

statistics, 1906—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1905-6. Number.	Publications during fiscal year 1905-6. Pages.	Number of names on mailing list.	Principal lines of work.
15	2	....	15	574	10,000	Chemistry; botany; analysis and inspection of foods, fertilizers, concentrated commercial feeding stuffs, and agricultural seeds; inspection of creamery glassware; mycology; pomology; nutrition investigations; poultry raising; entomology.
23	6	8	7	135	20,500	Chemistry; fertilizers; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; animal breeding; poultry raising; entomology; dairying.
23	10	6	18	248	37,000	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; diseases of plants and animals; digestion and feeding experiments; entomology; dairying; effect of electricity on plant growth.
15	8	9	10	820	43,000	Chemistry; analysis and control of fertilizers; bacteriology; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding and breeding experiments; entomology; stable hygiene.
20	6	....	7	638	13,000	Chemistry; soils; fertilizers; field experiments; horticulture; forestry; diseases of plants and animals; food and nutrition of man; plant and animal breeding; feeding experiments; entomology; dairying; farm management; farm statistics.
19	7	8	11	332	21,000	Fertilizers; field experiments; horticulture; biology; plant breeding; animal husbandry; diseases of animals; poultry culture; entomology; dairying; agricultural engineering.
31	15	7	7	159	10,000	Chemistry; soil survey; botany; field experiments; horticulture; diseases of plants and animals; feeding experiments; animal and plant breeding; entomology; dairying.
5	......	....	2	30	4,500	Horticulture; entomology; inspection of orchards and nurseries.
13	12	9	8	308	5,000	Chemistry; meteorology; botany; field experiments; dry farming; horticulture; feeding and breeding experiments; poultry experiments; entomology; dairying; irrigation and drainage.
25	17	12	5	242	15,860	Chemistry; botany; meteorology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; forestry; feeding and breeding experiments; entomology; dairying; irrigation.
9	4	6	6	253	3,500	Chemistry; meteorology; botany; soils; field experiments; horticulture; plant breeding; forestry; animal feeding and breeding; plant and animal diseases; entomology; irrigation.
14	9	8	8	132	13,000	Chemistry; botany; field experiments; horticulture; plant breeding; forestry; feeding and breeding experiments; entomology; dairying; poultry experiments.
14	5	6	6	878	6,500	Chemistry; oyster culture; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot, cylinder, and field experiments; horticulture; plant breeding; diseases of plants and animals; entomology; dairy husbandry; soil bacteriology; irrigation.
10	4	2	5	393		
13	10	6	6	90	3,200	Chemistry; botany; soils; field experiments; dry farming; horticulture; feeding experiments; entomology; dairying; irrigation.
27	......	12	21	1,002	43,000	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
23	16	16	11	841	15,890	Chemistry; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; poultry experiments; entomology; dairying.
17	8	7	3	142	32,000	Chemistry; soils; field experiments; horticulture; diseases of plants and animals; animal husbandry; poultry experiments; dairying; tests of farm machinery.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
North Dakota	Agricultural College	J. H. Worst, LL. D		Mar. —,1890
Ohio	Wooster	C. E. Thorne, M. S. A.	Apr. 25,1882	Apr. 2,1888
Oklahoma	Stillwater	W. L. English, B. S		Dec. 25,1890
Oregon	Corvallis	James Withycombe, M. Agr.		July —,1888
Pennsylvania	State College	H. P. Armsby, Ph. D., LL. D.		June 30,1887
Rhode Island	Kingston	H. J. Wheeler, Ph. D		July 30,1888
South Carolina	Clemson College	J. N. Harper, B. S., M. Agr.		Jan. —,1888
South Dakota	Brookings	J. W. Wilson, M. S. A.		Mar. 13,1887
Tennessee	Knoxville	H. A. Morgan, B. S. A.	June 8,1882	Aug. 4,1887
Texas	College Station	J. W. Carson, B. S. [a]		Apr. 3,1889
Utah	Logan	P. A. Yoder, Ph. D.		1890
Vermont	Burlington	J. L. Hills, Sc. D	Nov. 24,1886	Feb. 28,1888
Virginia	Blacksburg	A. M. Soule, B. S. A.	1888	1891
Washington	Pullman	E. A. Bryan, M. A., LL. D.		1891
West Virginia	Morgantown	J. H. Stewart, M. A.		June 11,1888
Wisconsin	Madison	W. A. Henry, D. Agr., D. Sc.	1883	1887
Wyoming	Laramie	B. C. Buffum, M. S.	1887	Mar. 1,1891
Total				

[a] Vice-director.

statistics, 1906—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1905-6. Number.	Publications during fiscal year 1905-6. Pages.	Number of names on mailing list.	Principal lines of work.
17	11	5	12	264	10,891	Chemistry; soils; botany; field experiments; plant breeding; horticulture; forestry; diseases of plants and animals; analysis of foods and spraying materials; inspection and analysis of paints, drugs, and proprietary products; feeding and breeding experiments; poultry experiments; drainage.
30	......	11	31	549	45,000	Chemistry; soils; field experiments; botany; horticulture; plant breeding; forestry; diseases of plants; feeding experiments; entomology.
12	10	8	7	140	22,575	Chemistry; field experiments; horticulture; plant breeding; forestry; botany; bacteriology; diseases of plants and animals; animal husbandry; entomology.
13	5	4	5	154	6,000	Chemistry; bacteriology; soils; fertilizers; field crops; horticulture; plant breeding and selection; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
20	6	2	14	308	17,100	Chemistry; meteorology; fertilizers; horticulture; plant diseases; field experiments; animal nutrition; feeding experiments; dairying; poultry experiments.
16	4	4	7	137	9,600	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; plant breeding; poultry experiments.
20	12	12	9	217	12,500	Chemistry; analysis and control of fertilizers; soils; botany; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; dairying.
13	8	7	7	150	11,000	Chemistry; botany; horticulture; field experiments; plant breeding; diseases of plants and animals; animal husbandry; entomology.
15	9	10	4	52	8,500	Chemistry; soil investigations; inspection of fertilizers; field experiments; horticulture; plant breeding; seeds; weeds; diseases of plants and animals; feeding experiments; entomology; dairying; poultry investigations; apiculture.
19	8	6	7	146	30,000	Chemistry; seed testing and feed inspection; soils; field experiments; horticulture; plant breeding; feeding experiments; diseases of plants and animals; entomology; irrigation.
21	12	9	4	82	5,600	Chemistry of soils; alkali soil investigations; field experiments; horticulture; diseases of plants and animals; breeding and feeding experiments; dairying; poultry experiments; entomology; irrigation; arid farming.
13	5	5	8	426	13,000	Chemistry; botany; bacteriology; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding and breeding experiments; dairying.
23	11	6	8	192	13,000	Chemistry; geology; biology; field experiments; horticulture; plant breeding; bacteriology; mycology; analysis of foods and soils; inspection of orchards; breeding and feeding experiments; veterinary science; entomology; cider and vinegar making; ferments; dairying.
16	12	12	5	230	6,000	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; dairying; irrigation.
13	3	4	12	316	8,000	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants and animals; inspection of orchards and nurseries; feeding and breeding experiments; poultry experiments; entomology; dairying.
31	23	5	12	834	20,000	Chemistry; bacteriology; soils; field experiments; horticulture; plant breeding; breeding and feeding experiments; dairying; irrigation and drainage; agricultural engineering.
10	8	5	5	231	4,000	Chemistry; mycology; botany; meteorology; soils; range improvement; fertilizers; field experiments; plant selection; food analysis; breeding and feeding experiments; irrigation.
950	434	389	463	17,501	758,842	

TABLE 9.—*Revenue and*

Station.	Federal appropriations.		State.	Individuals and communities.	Fees.	Farm products.
	Hatch fund.	Adams fund.				
Alabama (College)	$15,000.00	$5,000.00	$10,488.33			$696.44
Alabama (Canebrake)			2,500.00			900.00
Alabama (Tuskegee)			1,500.00			
Arizona	15,000.00	5,000.00	a 10,396.16		$57.00	1,041.56
Arkansas	15,000.00	5,000.00	b 34,984.92			1,472.95
California	15,000.00	5,000.00	c 27,277.04	$232.42	6,571.77	1,440.77
Colorado	15,000.00	5,000.00	d 14,000.00			
Connecticut (State)	7,500.00	2,500.00	e 15,950.00	7,949.30	a 20,491.92	356.49
Connecticut (Storrs)	7,500.00	2,500.00	1,800.00			
Delaware	15,000.00	5,000.00			286.00	
Florida	15,000.00	5,000.00				853.04
Georgia	15,000.00	5,000.00	851.42			2,711.11
Idaho	15,000.00	5,000.00				1,460.71
Illinois	15,000.00	5,000.00	95,000.00		890.00	708.84
Indiana	15,000.00	5,000.00	g 25,000.00			a 17,963.57
Iowa	15,000.00	5,000.00	31,509.36	100.00		9,821.82
Kansas	15,000.00	5,000.00	h 15,000.00			
Kentucky	15,000.00	5,000.00	a 13,977.08		24,462.73	a 6,965.88
Louisiana	15,000.00	5,000.00	15,000.00			3,385.33
Maine	15,000.00	5,000.00				
Maryland	15,000.00	5,000.00	10,000.00			5,182.63
Massachusetts	f 15,000.00	5,000.00	13,500.00		4,745.00	2,836.02
Michigan	15,000.00	5,000.00	h 15,530.17		2,860.00	c 2,610.10
Minnesota	15,000.00	5,000.00	c 37,189.18			c 11,188.21
Mississippi	15,000.00	5,000.00	h 9,000.00			c 2,519.20
Missouri (College)	15,000.00	5,000.00	4,000.00		6,102.66	5,644.48
Missouri (Fruit)			20,650.00			
Montana	15,000.00	5,000.00	5,424.44			4,825.62
Nebraska	15,000.00	5,000.00	10,000.00			14,575.67
Nevada	15,000.00	5,000.00				940.76
New Hampshire	15,000.00	5,000.00			1,635.88	
New Jersey (State)			k 31,300.00			
New Jersey (College)	15,000.00	5,000.00				
New Mexico	15,000.00	5,000.00				1,971.07
New York (State)	1,500.00	500.00	l 79,500.90			
New York (Cornell)	13,500.00	4,500.00	m 10,000.00			325.89
North Carolina	15,000.00	5,000.00	n 17,784.00			372.35
North Dakota	15,000.00	5,000.00	h 1,250.00			361.38
Ohio	15,000.00	5,000.00	a 80,010.86		140.75	11,885.51
Oklahoma	15,000.00	5,000.00	2,500.00			
Oregon	15,000.00	5,000.00			a 2,586.42	
Pennsylvania	15,000.00	5,000.00	1,835.05		13,049.55	3,106.55
Rhode Island	15,000.00	5,000.00				
South Carolina	15,000.00	5,000.00	2,635.53			1,526.05
South Dakota	15,000.00	5,000.00	1,000.00			
Tennessee	15,000.00	5,000.00			1,000.00	5,777.24
Texas	15,000.00	5,000.00			77.00	965.00
Utah	15,000.00	5,000.00	c 21,376.84			c 2,853.88
Vermont	15,000.00	5,000.00	1,503.51	22.65	2,805.00	
Virginia	15,000.00	5,000.00				
Washington	15,000.00	5,000.00			757.95	
West Virginia	15,000.00	5,000.00			9,066.94	3,672.54
Wisconsin	15,000.00	5,000.00	18,500.00		2,600.00	
Wyoming	15,000.00	5,000.00	177.26			2,608.30
Total	720,000.00	240,000.00	709,902.05	8,304.37	100,186.57	135,526.96

a Including balance from previous year.
b For biennium ending June 30, 1907.
c Including substations.
d Special appropriation for biennial period ended November 30, 1906.
e Including balance of $450 from previous year.
f Balance from previous year.
g For fiscal year ended October 31, 1906.
h For substations.

additions to equipment, 1906.

Miscellaneous.	Total.	Additions to equipment in 1906.						
		Buildings.	Library.	Apparatus.	Farm implements.	Live stock.	Miscellaneous.	Total.
$1,927.21	$33,111.98	$850.00	$425.00	$2,089.00	$438.00	$200.00	$110.00	$4,112.00
....	3,400.00	4,000.00	500.00	....	200.00	500.00	1,000.00	6,200.00
....	1,500.00	....	....	....	200.00	175.00	....	375.00
268.19	31,762.91	5,194.35	1.16	118.32	587.32	270.00	193.07	6,364.22
....	56,457.87	15,763.60	87.60	215.00	172.50	366.24	99.98	16,704.92
a 11,547.04	67,069.04	5,000.00	400.00	1,500.00	1,000.00	300.00	250.00	8,450.00
3,274.28	37,274.28	6,168.68	195.27	551.69	57.45	1,789.63	662.82	9,425.54
87.21	54,834.92	15,000.00	664.92	601.00	....	....	....	16,265.92
581.33	12,381.33	777.86	139.29	616.42	172.21	190.17	1,752.72	3,648.67
32.00	20,318.00	497.51	575.35	195.16	74.29	1.20	33.00	1,376.51
....	20,853.04	....	687.16	2,737.83	196.98	2,016.00	550.56	6,188.53
f 2,566.41	26,128.94	....	549.88	2,829.75	157.36	....	....	3,536.99
f 458.41	21,919.12	40,000.00	136.60	38.20	329.45	431.71	203.45	41,139.41
f 1,418.91	118,017.75	4,105.83	78.50	403.78	1,272.48	2,208.00	938.99	9,007.58
....	62,963.57	1,984.09	150.84	788.80	2,221.96	2,565.33	1,272.10	8,983.12
1,515.76	62,946.94	432.60	....	1,381.40	592.26	4,147.01	409.80	6,963.07
a 2,760.35	37,760.35	450.00	215.00	525.00	150.00	3,040.00	475.00	4,855.00
13.62	65,419.31	2,517.69	286.08	121.90	462.02	730.00	755.93	4,873.62
i 19,494.59	57,879.92	6,577.55	973.60	697.82	618.61	1,537.36	....	10,404.94
a 9,516.16	29,516.16	2,105.12	1,735.66	1,381.29	1,052.93	....	....	6,275.00
f 1,208.21	36,390.84	2,333.56	280.98	58.00	365.65	247.00	600.00	3,885.19
4,993.76	46,074.78	....	163.70	1,438.54	....	200.00	300.00	2,102.24
f 1,259.27	42,259.54	1,134.03	603.93	280.14	192.55	3,557.12	....	5,767.77
....	68,377.39	22,000.00	1,000.00	200.53	578.84	4,409.70	....	28,189.07
c 15,094.57	46,613.77	....	....	500.00	350.00	275.00	50.00	1,175.00
f 492.87	36,240.01	5,000.00	600.00	1,000.00	150.00	2,000.00	500.00	9,250.00
....	20,650.00	....	....	....	....	....	....	....
....	30,250.06	650.00	150.00	990.87	800.00	375.00	500.00	3,465.87
f 1,818.76	46,394.43	....	50.00	3,378.00	452.00	183.00	249.00	4,312.00
a 793.06	21,733.82	613.61	558.52	435.69	346.59	525.00	321.66	2.801.07
....	21,635.88	246.74	402.58	2,298.70	263.45	396.45	108.35	3,716.27
....	31,300.00	....	211.28	771.65	....	....	1,224.94	2,207.87
....	20,000.00	546.37	1,389.45	3,678.18	91.93	690.00	81.50	6,477.43
1,050.00	23,021.07	700.00	....	102.75	744.00	284.50	25.00	1,856.25
....	81,500.90	....	1,092.50	35.58	606.14	332.00	1,224.21	3,290.43
....	28,325.89	332.08	129.54	126.43	5.45	201.21	....	794.71
....	38,156.35	580.04	352.56	845.08	1,108.17	228.00	....	3,113.85
2,127.39	23,738.77	2,304.40	41.41	2,101.75	347.24	1,486.24	101.80	6,382.84
a 4,261.60	116,298.72	2,786.43	512.84	3,283.42	815.08	6,601.02	....	13,998.79
a 2,425.27	24,925.27	....	13.95	188.33	221.33	375.00	76.80	875.41
....	22,586.42	....	696.69	355.67	446.70	441.90	6,000.00	7,940.96
317.47	38,308.62	....	402.69	1,091.55	....	631.40	295.24	2,420.88
a 3,803.24	23,803.24	790.13	860.15	805.29	323.86	212.70	306.63	3,298.76
f 1,211.15	25,372.73	7,000.00	105.00	400.22	172.47	3,511.35	56.11	11,245.15
2,658.11	23,658.11	1,898.00	6.06	212.78	270.98	450.00	98.00	2,935.82
1,562.06	28,339.30	951.19	1,044.81	4,372.56	355.17	511.00	....	7,234.73
2,496.31	23,538.31	407.42	67.77	30.65	118.96	96.28	102.23	823.31
a 395.00	44,625.72	392.64	1,102.14	2,655.13	1,529.16	1,340.87	694.13	7,714.07
....	24,331.16	2,999.85	706.99	3,329.91	614.38	234.75	....	7,885.88
142.60	20,142.60	444.25	372.14	2,754.13	47.13	200.00	151.30	3,968.95
....	20,757.95	1,000.00	100.00	958.13	25.00	314.05	606.85	3,004.03
....	32,739.48	1,838.23	646.80	662.16	399.94	299.90	15.00	3,862.03
....	41,100.00	1,501.65	601.85	1,218.45	532.13	724.42	416.58	4,995.08
....	22,785.56	....	12.05	87.35	476.40	175.17	....	750.97
103,572.17	2,017,492.12	169,875.50	22,080.29	57,439.98	22,706.52	51,977.68	22,812.75	346,892.72

i Including balance of $15,612.33 from previous year and a refund of $550.
j Including balance of $382.30 from previous year.
k For fiscal year ended October 31, 1906.
l For fiscal year ended October 1, 1906.
m Estimated amount of State appropriation spent for experimental purposes.
n Estimated amount of State appropriation spent for experimental purposes during fiscal year ended December 1, 1906.

TABLE 10.—*Expenditures from United States appropriation of March 2, 1887,*

Station.	Amount of appropriation.	Classified expenditures.						
		Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.
Alabama	$15,000.00	$7,703.00	$1,384.19	$769.94	$107.00	$357.46	$387.31	$863.50
Arizona	15,000.00	6,823.54	4,332.41	....	408.64	275.14	70.08	637.90
Arkansas	15,000.00	7,724.92	2,152.24	1,119.35	249.85	435.87	161.75	481.63
California	15,000.00	7,702.66	3,704.61	373.01	595.51	84.96	142.50	182.51
Colorado	15,000.00	10,234.50	446.70	1,677.52	379.42	129.41	4.35	....
Connecticut (State)	7,500.00	7,500.00	....	....	....	....	....	....
Connecticut (Storrs)	7,500.00	3,545.81	1,451.74	56.50	183.54	75.72	116.63	402.62
Delaware	15,000.00	9,545.78	1,021.03	756.14	134.23	119.43	301.16	265.19
Florida	15,000.00	8,853.75	1,345.31	925.70	242.24	209.48	417.65	157.85
Georgia	15,000.00	6,815.00	3,235.44	1,673.06	234.28	204.89	170.26	....
Idaho	15,000.00	8,298.30	2,164.87	748.98	173.42	181.00	525.85	202.78
Illinois	15,000.00	8,003.19	3,227.16	1,353.63	762.51	271.81	120.00	....
Indiana	15,000.00	8,357.04	2,152.08	1,877.22	554.05	79.90	156.88	148.92
Iowa	15,000.00	9,324.94	....	1,718.83	428.35	451.22	....	437.08
Kansas	15,000.00	7,963.49	4,038.37	458.91	114.67	276.79	....	130.32
Kentucky	15,000.00	11,715.80	....	866.26	171.01	62.72	480.14	48.83
Louisiana	15,000.00	14,105.16	....	887.34	....	....	....	....
Maine	15,000.00	7,704.80	1,561.47	242.67	337.77	236.64	592.56	135.70
Maryland	15,000.00	7,757.36	3,010.37	452.01	329.30	260.01	380.22	261.69
Massachusetts	15,000.00	6,539.52	3,003.07	719.01	438.09	168.01	245.42	406.54
Michigan	15,000.00	7,150.37	3,944.16	210.65	451.07	139.82	161.47	152.36
Minnesota	15,000.00	7,983.37	....	624.33	217.96	2.00	1,332.20	43.19
Mississippi	15,000.00	7,042.93	1,602.63	1,883.36	133.58	316.85	106.05	....
Missouri	15,000.00	5,617.66	2,013.90	521.61	283.31	63.50	26.55	4.85
Montana	15,000.00	9,464.72	2,462.05	1,062.31	329.78	473.28	67.76	280.15
Nebraska	15,000.00	9,143.06	2,043.95	875.40	562.37	49.45	....	116.62
Nevada	15,000.00	8,536.93	3,160.83	197.60	165.40	90.77	592.57	199.37
New Hampshire	15,000.00	8,415.47	2,415.11	1,146.47	72.09	183.19	645.26	22.40
New Jersey	15,000.00	10,250.00	797.56	188.70	769.82	72.27	333.70	82.50
New Mexico	15,000.00	7,229.75	2,425.04	299.56	437.32	687.88	373.55	206.18
New York (State)	1,500.00	939.49	....	205.40	64.54	49.65	....	12.75
New York (Cornell)	13,500.00	10,108.12	1,118.24	770.58	214.76	56.14	4.14	102.37
North Carolina	15,000.00	9,766.69	1,778.35	553.92	434.90	71.06	91.10	82.25
North Dakota	15,000.00	6,597.92	3,861.71	1,817.64	290.31	39.68	376.16	42.46
Ohio	15,000.00	14,910.00	....	....	....	....	....	....
Oklahoma	15,000.00	6,243.74	3,057.38	1,788.31	264.47	196.37	310.50	115.35
Oregon	15,000.00	9,671.65	2,851.74	203.70	60.96	135.05	....	459.52
Pennsylvania	15,000.00	9,576.43	1,137.74	749.79	471.91	....	179.48	749.84
Rhode Island	15,000.00	8,738.82	2,132.92	53.01	206.34	177.06	478.51	40.58
South Carolina	15,000.00	10,821.38	1,448.56	630.00	94.54	87.56	83.73	400.22
South Dakota	15,000.00	7,445.44	4,046.54	1,097.43	210.49	196.41	2.85	122.83
Tennessee	15,000.00	8,580.00	3,785.03	370.95	293.44	91.45	300.85	142.61
Texas	15,000.00	6,933.33	2,531.18	1,434.66	283.98	198.93	46.51	312.63
Utah	15,000.00	6,206.89	3,062.77	438.63	487.49	73.51	15.00	396.42
Vermont	15,000.00	6,071.58	3,558.70	723.62	616.98	142.78	440.86	179.77
Virginia	15,000.00	9,314.25	1,429.99	1,375.77	435.53	274.15	92.74	372.52
Washington	15,000.00	9,750.28	1,141.95	732.52	29.00	....	1,155.00	86.11
West Virginia	15,000.00	10,811.05	....	156.78	383.66	205.14	541.76	359.19
Wisconsin	15,000.00	8,509.00	1,503.75	39.70	116.80	50.00	192.34	464.60
Wyoming	15,000.00	7,703.63	1,528.97	1,187.57	244.02	257.02	700.00	308.89
Total	720,000.00	415,752.51	99,071.81	38,016.05	14,470.70	8,261.43	12,914.40	10,621.59

for the agricultural experiment stations for year ended June 30, 1906.

Classified expenditures—Continued.											
Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Buildings and repairs.	Balance.
$1,139.10	$430.33	....	$518.71	$318.49	....	$153.74	....	$102.45	$15.00	$749.78	....
247.92	219.24	$203.85	1.16	587.32	$30.92	118.32	$378.40	441.60	15.68	207.88	....
656.16	45.75	132.45	87.60	172.50	99.98	185.00	366.24	566.54	181.00	181.17	....
239.41	313.78	219.55	20.19	48.50	76.74	420.60	....	736.21	117.21	22.05	....
226.95	....	....	169.27	....	494.42	236.11	110.00	807.52	83.83	....	....
....	....	....	....	....	....	....	....	....	....	....	....
477.17	....	230.50	68.50	94.14	88.80	94.70	166.55	223.98	15.00	208.10	....
297.74	30.23	88.89	624.40	74.29	179.70	195.16	1.20	616.27	195.68	497.51	$55.97
359.65	506.15	355.15	394.77	196.98	123.47	132.01	76.00	677.49	16.20	10.15	....
619.57	123.90	490.78	18.03	127.36	....	11.60	248.00	257.83	20.00	750.00	....
693.29	....	421.12	136.60	384.83	70.74	38.20	431.71	432.83	17.25	78.23	....
524.20	3.35	28.88	60.00	179.23	5.10	148.76	....	263.48	44.56	4.14	....
651.44	....	....	121.12	636.85	64.50	....	....	88.88	15.00	96.12	....
385.64	....	....	....	28.35	....	703.83	1,074.16	....	15.00	432.60	....
456.62	....	13.28	88.27	452.60	56.18	436.52	13.50	87.00	39.97	373.51	....
187.45	....	....	286.08	139.50	649.08	66.90	....	215.63	110.60	....	....
....	....	....	....	....	....	....	....	....	7.50	....	....
340.71	142.85	1,298.85	744.73	284.49	38.42	510.80	44.62	449.01	21.50	312.41	....
115.27	213.60	371.30	280.98	225.55	48.55	9.45	247.00	735.64	15.00	286.70	....
525.57	569.43	699.10	21.10	246.05	51.52	292.62	195.25	229.66	25.00	625.04	....
501.22	13.00	215.39	554.24	10.85	66.56	231.89	853.27	232.52	....	111.16	....
876.09	....	2,014.30	....	407.80	439.67	73.86	622.34	178.30	7.25	177.34	....
391.79	44.57	1,789.41	124.15	579.81	10.84	....	31.40	200.34	15.00	727.29	....
706.22	....	3,233.55	95.87	130.00	....	19.80	2,051.99	189.95	15.00	26.24	....
....	....	....	141.99	260.10	85.65	357.21	....	....	15.00	....	....
406.06	....	809.48	....	233.65	83.10	270.24	103.11	120.11	15.00	168.40	....
325.23	24.50	222.55	358.52	146.52	297.16	5.50	75.00	444.10	33.00	124.45	....
460.83	224.93	....	165.08	167.72	108.35	500.77	....	286.65	32.88	152.80	....
210.55	90.00	....	878.40	7.48	81.50	145.43	40.00	141.50	364.22	546.37	....
732.63	111.75	1,112.86	....	482.35	24.33	102.75	284.50	474.55	15.00	....	....
5.68	....	39.80	88.44	....	....	....	1.50	8.02	....	....	84.73
129.10	10.32	....	129.54	5.45	201.21	126.43	....	135.15	56.37	332.08	....
301.61	211.73	619.77	39.41	206.94	128.82	17.27	53.00	223.30	15.00	404.88	....
252.42	....	611.91	11.41	342.48	59.40	209.94	....	176.16	15.00	304.40	....
....	....	....	....	....	....	....	....	50.00	40.00	....	....
497.82	....	625.94	13.95	361.16	76.80	11.00	376.00	296.21	15.00	750.00	....
216.68	36.00	395.21	258.40	....	101.35	165.62	261.90	167.22	15.00	....	....
22.60	153.53	944.76	233.13	98.30	....	238.66	72.00	184.13	40.00	147.70	....
286.71	276.20	538.69	439.75	485.13	131.49	3.55	212.70	211.35	15.00	572.19	....
357.03	264.48	48.22	105.80	172.47	11.50	....	16.00	148.92	56.11	253.48	....
399.03	....	539.57	6.06	145.98	86.06	212.78	323.19	126.10	15.00	24.24	....
286.97	178.30	162.07	192.79	19.30	....	235.72	....	324.32	15.00	21.20	....
422.67	142.16	1,507.56	67.77	118.96	102.23	30.65	96.28	332.08	31.00	407.42	....
393.53	127.75	1,063.07	29.92	282.73	177.66	567.05	865.87	481.16	27.50	303.04	....
75.33	201.48	955.75	239.44	149.99	230.24	177.70	....	409.46	76.42	750.00	....
845.70	6.85	....	35.42	47.13	151.30	16.00	200.00	168.40	40.00	194.25	....
613.14	....	395.27	....	292.50	....	....	314.05	475.18	15.00	....	....
206.99	53.00	622.84	410.10	73.00	69.00	253.97	....	423.19	15.00	414.82	.51
1,179.12	80.00	544.50	425.57	244.25	285.92	621.45	53.00	308.43	15.00	366.57	....
355.45	....	976.63	12.05	476.40	139.23	87.35	175.17	365.58	25.00	457.04	....
19,602.06	4,849.16	24,542.80	8,698.71	10,145.48	5,227.50	8,436,81	10,434.90	14,214.40	2,025.73	12,572.75	141.21

TABLE 11.—*Expenditures from United States appropriation of March 16, 1906,*

Station.	Amount of appropriation.	Classified expenditures.						
		Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.
Alabama	$5,000.00					$64.90		$99.43
Arizona	5,000.00	$892.47						993.32
Arkansas	5,000.00		$19.37			64.25		167.29
California	5,000.00	2,242.83	974.24		$44.50	15.61		6.73
Colorado	5,000.00		200.00					90.59
Connecticut (State)	2,500.00	1,704.17	382.03			3.80		58.64
Connecticut (Storrs)	2,500.00	616.66	186.31		57.30	12.69		484.94
Delaware	5,000.00		12.00			1.25		20.54
Florida	5,000.00				37.50			534.84
Georgia	5,000.00	675.00	625.00					43.31
Idaho	5,000.00				29.50	75.00		182.82
Illinois	5,000.00	391.67	235.00			63.00		
Indiana	5,000.00							
Iowa	5,000.00		460.08					80.74
Kansas	5,000.00	608.36	611.05					
Kentucky	5,000.00	124.95						543.99
Louisiana	5,000.00	2,164.14	476.65		48.90	12.35	$291.30	54.38
Maine	5,000.00	1,625.00	320.42			70.53	73.95	145.75
Maryland	5,000.00					11.20		335.56
Massachusetts	5,000.00	1,373.36	277.77			32.20		44.30
Michigan	5,000.00		31.50		.10	5.52		48.79
Minnesota	5,000.00	3,580.59			7.28		43.68	149.79
Mississippi	5,000.00				1.05	198.50		
Missouri	5,000.00		94.00					98.19
Montana	5,000.00	1,037.50	290.97		5.20	51.60		
Nebraska	5,000.00	99.95	483.50		4.25	21.44		353.68
Nevada	5,000.00					232.77		556.29
New Hampshire	5,000.00	929.00	528.48	$5.80	21.20			20.55
New Jersey	5,000.00		33.00					
New Mexico	5,000.00	985.00	762.28				60.35	503.08
New York (State)	500.00				.01			499.99
New York (Cornell)	4,500.00		22.15			32.39		391.25
North Carolina	5,000.00	965.32				9.84		518.14
North Dakota	5,000.00	479.15	611.85					
Ohio	5,000.00	185.00	13.80					289.28
Oklahoma	5,000.00							
Oregon	5,000.00							
Pennsylvania	5,000.00	305.02						
Rhode Island	5,000.00	496.30						143.26
South Carolina	5,000.00		25.00		43.50	118.75		10.00
South Dakota	5,000.00							
Tennessee	5,000.00							
Texas	5,000.00		29.12		37.50		32.45	1,840.93
Utah	5,000.00	919.59	209.05					456.15
Vermont	5,000.00	570.98	101.90					
Virginia	5,000.00					42.42		1,605.88
Washington	5,000.00	403.00						55.78
West Virginia	5,000.00	1,770.00			53.00			
Wisconsin	5,000.00	2,665.00	706.34			51.81		213.07
Wyoming	5,000.00					4.75		621.38
Total	240,000.00	27,810.01	8,722.86	5.80	390.79	1,196.57	501.73	12,262.65

for the agricultural experiment stations for year ended June 30, 1906.

Classified expenditures—Continued.											
Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Buildings and repairs.	Balance.
....	....	....	....	$218.98	....	$1,627.10	....	....	....	$9.48	$2,980.11
....	....	....	....	880.11	....	1,984.10	....	....	....	250.00	....
$619.23	....	$137.26	$19.52	1,174.20	....	1,646.11	$917.09	....	....	235.68	....
....	....	....	6.60	130.65	....	49.69	....	$1,455.99	....	....	73.16
56.75	....	....	1,898.54	73.60	$200.33	2,456.19	....	24.00	....	....	....
80.28	$96.88	....	....	75.25	....	65.50	....	33.45	....	....	....
299.19	....	.65	67.00	127.68	....	417.11	30.42	78.35	....	121.70	....
....	....	....	....	....	189.49	1,813.03	....	14.03	....	....	2,949.66
19.67	....	....	291.39	....	....	2,174.71	1,940.00	....	....	....	1.89
159.40	....	250.00	448.30	626.28	106.51	1,966.20	....	....	....	100.00	....
....	....	....	178.54	1,487.95	....	1,228.23	....	....	....	....	1,817.96
....	34.00	741.92	....	....	....	....	3,510.00	24.41	....	....	....
....	....	....	....	....	....	....	....	....	....	....	5,000.00
301.94	34.00	667.01	....	85.00	77.50	622.68	2,671.05	....	....	....	....
1.27	....	602.75	4.35	98.25	....	56.57	3,005.00	12.40	....	....	....
....	....	....	....	....	....	4,331.06	....	....	....	....	....
80.22	....	394.66	1.10	168.79	....	387.82	696.00	9.40	$7.50	206.79	....
154.56	38.68	217.14	427.21	775.27	....	870.49	31.00	....	....	250.00	....
209.01	....	....	116.20	271.75	445.20	1,159.76	1,732.00	233.21	....	250.00	236.11
98.59	274.28	....	19.12	94.50	....	2,662.59	....	123.29	....	....	....
142.75	....	....	347.12	.60	....	1,115.22	....	....	....	....	3,308.40
....	....	....	184.86	325.00	....	....	620.00	....	....	88.80	....
....	....	....	....	....	....	....	4,698.46	101.99	....	....	....
614.79	119.71	2,401.22	....	387.00	....	395.95	889.14	....	....	....	....
4.35	....	....	....	....	....	784.04	....	32.15	....	211.32	2,582.87
30.70	....	....	48.93	307.16	70.00	3,513.19	....	67.20	....	....	....
....	....	....	364.14	164.56	368.80	3,044.38	....	....	42.00	....	227.06
574.21	343.96	....	237.50	308.03	....	1,388.08	396.45	....	....	246.74	....
23.65	165.10	....	511.05	84.45	....	3,532.75	650 00	....	....	....	....
222.26	9.00	16.35	81.33	842.89	....	950.55	471.66	95.25	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
....	24.80	143.01	....	287.82	205.99	2,654.67	606.68	....	....	14.09	117.15
34.03	303.57	....	313.15	1,484.02	....	964.41	175.00	....	....	232.52	....
1,530.00	....	....	....	1,879.00	....	....	500.00	....	....	....	....
260.00	....	....	68.95	....	....	2,689.79	....	7.20	....	....	1,485.98
....	....	....	....	....	....	....	....	....	....	....	5,000.00
....	....	....	....	....	....	....	....	....	....	....	5,000.00
....	....	....	1,543.21	613.31	....	2,533.87	....	....	....	....	4.59
39.97	3.00	....	222.21	531.20	....	835.95	....	192.31	....	....	2,535.80
28.87	....	154.90	....	132.50	....	498.70	2,295.00	2.90	....	250.00	1,439.88
....	....	....	....	....	....	....	....	....	....	....	5,000.00
1.14	....	....	852.02	....	....	4,146.84	....	....	....	....	....
37.15	....	....	....	123.61	28.75	741.25	....	....	....	6.15	2,123.09
38.67	....	99.07	1,477.34	72.08	144.68	1,172.07	8.80	209.08	....	15.36	178.06
312.88	....	....	464.50	147.43	....	3,152.31	....	....	....	250.00	....
....	....	....	336.72	....	....	2,738.13	....	24.80	....	250.00	2.05
503.33	....	....	19.00	25.00	....	50.00	24.00	....	....	....	3,919.89
27.07	....	....	6.58	48.75	....	813.06	....	140.66	....	....	2,140.88
392.16	255.75	....	148.11	42.30	49.18	91.22	....	385.06	....	....	....
....	....	....	....	352.07	....	301.80	3,700.00	20.00	....	....	....
6,898.09	1,702.73	5,825.94	10,704.59	14,447.04	1,886.43	63,627.17	29,567.75	3,287.13	49.50	2,988.63	48,124.59

TABLE 12.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved March 2, 1887, and March 16, 1906.*[a]

State or Territory.	Hatch Act.		Adams Act.
	1888–1905.	1906.	1906.
Alabama	$269,999.34	$15,000.00	$5,000.00
Arizona	234,803.15	15,000.00	5,000.00
Arkansas	268,163.12	15,000.00	5,000.00
California	270,000.00	15,000.00	5,000.00
Colorado	269,963.24	15,000.00	5,000.00
Connecticut	270,000.00	15,000.00	5,000.00
Dakota (Territory)	56,250.00	....	....
Delaware	269,438.84	15,000.00	5,000.00
Florida	269,966.11	15,000.00	5,000.00
Georgia	269,983.55	15,000.00	5,000.00
Idaho	195,000.00	15,000.00	5,000.00
Illinois	270,000.00	15,000.00	5,000.00
Indiana	269,901.19	15,000.00	5,000.00
Iowa	270,000.00	15,000.00	5,000.00
Kansas	270,000.00	15,000.00	5,000.00
Kentucky	269,996.57	15,000.00	5,000.00
Louisiana	270,000.00	15,000.00	5,000.00
Maine	269,999.62	15,000.00	5,000.00
Maryland	269,967.40	15,000.00	5,000.00
Massachusetts	270,000.00	14,617.70	5,000.00
Michigan	270,000.00	15,000.00	5,000.00
Minnesota	270,000.00	15,000.00	5,000.00
Mississippi	270,000.00	15,000.00	5,000.00
Missouri	265,097.24	15,000.00	5,000.00
Montana	180,000.00	15,000.00	5,000.00
Nebraska	269,932.16	15,000.00	5,000.00
Nevada	269,939.32	15,000.00	5,000.00
New Hampshire	270,000.00	15,000.00	5,000.00
New Jersey	269,961.97	15,000.00	5,000.00
New Mexico	234,998.90	15,000.00	5,000.00
New York	269,945.27	15,000.00	5,000.00
North Carolina	270,000.00	15,000.00	5,000.00
North Dakota	227,330.62	15,000.00	5,000.00
Ohio	270,000.00	15,000.00	5,000.00
Oklahoma	209,270.80	15,000.00	5,000.00
Oregon	256,631.82	15,000.00	5,000.00
Pennsylvania	269,967.95	15,000.00	5,000.00
Rhode Island	270,000.00	15,000.00	5,000.00
South Carolina	269,542.15	15,000.00	5,000.00
South Dakota	213,250.00	15,000.00	5,000.00
Tennessee	270,000.00	15,000.00	5,000.00
Texas	270,000.00	15,000.00	5,000.00
Utah	235,000.00	15,000.00	5,000.00
Vermont	270,000.00	15,000.00	5,000.00
Virginia	269,992.57	15,000.00	5,000.00
Washington	210,000.00	15,000.00	5,000.00
West Virginia	269,969.22	15,000.00	5,000.00
Wisconsin	270,000.00	15,000.00	5,000.00
Wyoming	255,000.00	15,000.00	5,000.00
Total	12,489,262.12	719,617.70	240,000.00

[a] The figures in this table were furnished by the Treasury for the use of this Department by the courtesy of the honorable Secretary of the Treasury.

PROGRESS IN AGRICULTURAL EDUCATION, 1906.

By Dick J. Crosby,

Expert in Agricultural Education, Office of Experiment Stations.

INTRODUCTION.

The attitude of the thinking public toward industrial education in general and agricultural education in particular is rapidly assuming a decidedly friendly aspect. There are many indications of this. The President of the United States in his message at the beginning of the second session of the Fifty-ninth Congress said:

There is no longer any failure to realize that farming, at least in certain branches, must become a technical and scientific profession. This means that there must be open to farmers the chance for technical and scientific training, not theoretical merely, but of the most severely practical type. The farmer represents a peculiarly high type of American citizenship, and he must have the same chance to rise and develop as other American citizens have. Moreover, it is exactly as true of the farmer, as it is of the business man and the wage worker, that the ultimate success of the nation of which he forms a part must be founded not alone on material prosperity but upon high moral, mental, and physical development. This education of the farmer—self-education by preference, but also education from the outside, as with all other men—is peculiarly necessary here in the United States, where the frontier conditions even in the newest States have now nearly vanished, where there must be a substitution of a more intensive system of cultivation for the old wasteful farm management, and where there must be a better business organization among the farmers themselves.

Several factors must cooperate in the improvement of the farmer's condition. He must have the chance to be educated in the widest possible sense—in the sense that keeps ever in view the intimate relationship between the theory of education and the facts of life. In all education we should widen our aims. It is a good thing to produce a certain number of trained scholars and students; but the education superintended by the State must seek rather to produce a hundred good citizens than merely one scholar, and it must be turned now and then from the class book to the study of the great book of nature itself. This is especially true of the farmer, as has been pointed out again and again by all observers most competent to pass practical judgment on the problems of our country life. All students now realize that education must seek to train the executive powers of young people and to confer more real significance upon the phrase "dignity of labor," and to prepare the pupils so that in addition to each developing in the highest degree his individual capacity for work, they may together help create a right public opinion, and show in many ways social and cooperative spirit. * * *

While the farmers must primarily do most for themselves, yet the Government can also do much. The Department of Agriculture has broken new ground in many directions, and year by year it finds how it can improve its methods and develop fresh usefulness. Its constant effort is to give the governmental assistance in the most effective way; that is, through associations of farmers rather than to or through individual

farmers. It is also striving to coordinate its work with the agricultural departments of the several States, and so far as its own work is educational, to coordinate it with the work of other educational authorities. Agricultural education is necessarily based upon general education, but our agricultural educational institutions are wisely specializing themselves, making their courses relate to the actual teaching of the agricultural and kindred sciences to young country people or young city people who wish to live in the country.

Great progress has already been made among farmers by the creation of farmers' institutes, of dairy associations, of breeders' associations, horticultural associations, and the like. * * * The Department can and will cooperate with all such associations, and it must have their help if its own work is to be done in the most efficient style.

Other striking indications of this friendly attitude toward agricultural education are found in the numerous bills introduced into the Senate and the House of Representatives at the second session of the Fifty-ninth Congress providing for additional aid to agricultural colleges, for agricultural schools of secondary grade, for Federal aid for secondary courses in agriculture, home economics and mechanic arts, and for branch experiment stations in connection with agricultural schools. The State legislatures also are responding to the demand for more liberal funds for agricultural and mechanical colleges as well as for aid to technical instruction of lower grade in public schools. Furthermore, the programme of nearly every meeting of farmers, teachers, and school officers in the United States during 1906 has included some consideration of the subject of agricultural education.

A public sentiment thus aroused to the point of admitting defects in the scheme for educating our industrial youth and giving liberally of the public funds to remedy these defects will accomplish results as rapidly as the available experts can overhaul and improve the machinery of education.

EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

The United States Department of Agriculture through its different Bureaus has responded to many and varied requests for aid in promoting agricultural education in the colleges, the secondary schools, and the elementary schools. The attitude of the Secretary of Agriculture with reference to the educational work of this Department is shown by the following statements from his report for 1906:

With the development of the Department's work along educational lines it has become clear that it may accomplish important and valuable service as a central agency for the promotion of agricultural education in cooperation with the State departments of agriculture and education, the agricultural colleges and experiment stations, and the State and national agricultural organizations. The most important lines of educational effort in which the Department should engage may be briefly outlined as follows:

(1) To aid the agricultural colleges to reduce the results of the investigations made by this Department and the experiment stations to pedagogical form for use in agricultural colleges and schools of different grades. This work is now proceeding too slowly to keep pace with the accumulation of material, and the lack of well-ordered manuals and illustrative materials is a great hindrance to the effective organization of agricultural instruction.

(2) To promote the efficiency of agricultural instruction in the negro land-grant colleges, in order that the funds granted for negro education by the Federal Government may contribute toward keeping the negro on the farm and making him a more efficient factor in agricultural production for his own good and that of the nation rather than, as is largely the case at present, drawing him away from the farm into the uncertainties and dangers of city life.

(3) To aid the agricultural organizations in the several States in promoting an efficient organization of agricultural high schools, consolidated common schools, and other educational agencies best adapted to secure a high state of prosperity and contentment in rural life. It is along these lines that the great educational effort of the immediate future is to be made. The forces behind the movement for industrial education have hitherto devoted themselves very largely to the promotion of instruction in the city industries. It is now apparent that a similar work needs to be done for the great fundamental industries grouped under agriculture. Much work will be required to bring the masses of our agricultural population into sympathetic touch with the progressive movement in education and to secure for them a school system in harmony with their environment and their relations to the world's work and civilization. As the nation's representative of agricultural enlightenment and progress, this Department should be in a position to render effective aid in this enterprise, on the success of which depends so largely the permanent prosperity and contentment of our agricultural people.

(4) Since the success of agricultural instruction in the public schools will depend very largely on the teachers, this Department should aid the agricultural colleges and other State educational institutions in preparing and inaugurating training courses for teachers of agriculture in secondary and elementary schools.

(5) Since agriculture as a fundamental industry is of vital importance to all our people, this Department should present such results of its work and that of the experiment stations at home and abroad as are adapted to instructional purposes in connection with nature study and elementary agriculture in a form available to teachers and pupils in both country and city, the object being to impress our youth with the dignity, value, and attractiveness of country life and pursuits.

The Chief of the Weather Bureau reports as follows concerning the teaching of meteorology:

The officials of the Weather Bureau have had their attention forcibly drawn to the teaching of meteorology by the increased recognition of that science as a branch of study appropriate to high schools, normal schools, colleges, and universities. * * * Elementary climatology considered as a part of geography is taught in about 1,000 graded schools. Elementary climatology and meteorology are taught in connection with geology in about 7,000 high schools, or seven-eighths of the whole number that are catalogued by the Bureau of Education.

Specific courses in meteorology or climatology are given in about 140 out of 177 public normal schools, although in some of these the subject is taught in connection with physical geography. Out of 311 colleges and universities from which direct replies have been received 59 state that they have specific courses in meteorology, 133 teach this in connection with some other subject, and 119 pay no attention to it. The corresponding percentages are 19, 43, and 38, and probably the replies from other colleges will not alter these ratios very much. In fully one-half of these institutions,

from the lower schools to the higher universities, some form of laboratory method is pursued—that is to say, students are required to make personal observations, experiments, and deductions. They study the daily weather map and develop habits of individual thought. In a matter so complex as the weather no text-books can replace the daily map, personal observations, and independent study.

In addition to the popular work of the high schools and colleges, a higher class of work has been carried out by the scientific schools and universities. This special technical instruction is divided into two parts—that which is done by the scientific faculty as such and that which is done by Weather Bureau officials temporarily appointed as instructors, who sometimes do this educational work without extra compensation from the colleges. There are 19 of the latter and about 50 of the former.

Effort is being made to correlate and reduce to a uniform system the standard of instruction to be given at these institutions, so that, at least in some cases, these scientific schools may prepare men for the highest work that is required of a Weather Bureau official.

The school garden work of the Bureau of Plant Industry is summarized by the Chief of that Bureau as follows:

Public interest in the school garden movement has not waned during the year. In fact the distribution of special collections of flower and vegetable seeds for individual school gardens, as well as of a collection of seeds for decorating school grounds, has been more general than was the case the preceding year. Every State and Territory, except Nevada and Wyoming, are represented upon the mailing list of the Bureau in its school garden work. The distribution of seeds for this purpose during the past year amounted to 155,870 packets of flower seeds, 150,520 packets of vegetable seeds, and 71,150 packets of decorative flower seeds, making a total of 377,540 packets. It is safe to say that about 75,500 school gardens have been provided for in the last year's distribution, or about twice as many as were reached in the distribution of the preceding year. The largest distribution of the past year was made to the State of Illinois, the second largest to New York, the third largest to Pennsylvania, with Massachusetts fourth upon the list. During the preceding year New York received the largest distribution, Ohio the second largest, and New Jersey third largest. It is evident that the school garden movement is westward bound.

It can safely be said that more than a thousand teachers of schools in various parts of the country are interested in this work. The gratifying reports which are received from this distribution make it evident that it is meeting with good results and is filling a very useful place in the school work of our country. It is certain that hundreds of children who knew little or nothing of the manner of growth and methods of cultivation of the various garden crops and flowers have been given the rudiments of agriculture through the distribution of seeds to the schools, and that many minds which were never before interested in agriculture have a live interest in the subject at the present time.

The work in cooperation with the normal schools of Washington, D. C., has been continued on a plat of about 3 acres in the northeast corner of the Department grounds. This is the most extensive work of this kind yet undertaken on the grounds, and has been very successful. The work, as in preceding years, has been in charge of Miss Susan B. Sipe, of Normal School No. 1, and has been continued throughout the summer as a vacation garden for the school children of the city. Great interest has been manifested in this work.

The Forester reports that "educational work through addresses was greatly extended during the year, both in the number of meetings held and in the territory covered. Systematic work was carried

on in Kansas, Oklahoma, and Alabama, and twenty-three individual meetings were addressed upon special request in fourteen States and one Territory. Many of these addresses were illustrated by lantern slides. On several occasions a representative of the Service accompanied the 'corn specials,' which were run to carry exhibits of progressive farm methods."

The total number of publications issued by the Department in 1906 was 1,171. Of these, 513 were original, comprising 22,444 pages. The number of copies of publications issued during the year aggregated 13,488,021. The requests from educational institutions for these publications are constantly increasing in number. It is not an unusual thing to send out several thousand publications in a single day for use in public school classes. The Farmers' Bulletins especially are coming to be used extensively in college and school classes, granges, farmers' clubs, and reading circles.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations in relation to educational institutions engaged in promoting the teaching of agriculture has become so broad and the demands on this Office for services in aid of this movement have become so varied that it has been deemed best to divide the educational work of the Office into two sections. One of these deals with the agricultural colleges and schools; the other promotes the interests of the farmers' institutes and other forms of extension work in agriculture.

The work of the Office relating to the agricultural colleges and schools during the past year has included (1) the collection and publication of information regarding the progress of agricultural education at home and abroad; (2) studies of different grades of American and foreign schools in which agriculture is taught; (3) work in cooperation with the Association of American Agricultural Colleges and Experiment Stations and other important associations dealing with educational matters; and (4) the giving of aid to agricultural colleges and schools and to State and local school authorities along lines of agricultural education.

RELATION TO AMERICAN INSTITUTIONS.

The department of agricultural education maintained in Volume XVII of the Experiment Station Record has contained 125 abstracts of important text-books, manuals, and other publications relating to this subject, besides numerous notes concerning agricultural colleges and schools.

There have also been prepared and published the annual statistics and organization lists of the agricultural colleges and experiment stations, a bulletin on School Gardens, a circular on A Four-Year

Course in Agriculture, a review of progress in agricultural education in 1905, and a Yearbook article on "The use of illustrative material in teaching agriculture in rural schools." A bulletin containing exercises and describing illustrative material for teaching agriculture in elementary schools has been prepared for the printer. The work of card indexing references to American and foreign schools in which agriculture is taught has been continued. The number of cards now completed is about 3,300, of which about 2,300 were added during the past year. The card directory of teachers and investigators in agricultural subjects has been revised and about 200 names added, making a total of about 1,400 cards now in the directory.

The Director of this Office has continued to act as bibliographer of the Association of American Agricultural Colleges and Experiment Stations and as chairman of the committee of that association on instruction in agriculture. Upon invitation of the committee the expert in agricultural education of this Office has acted as its secretary, conducting correspondence for the committee and assisting in the preparation of reports. The giving of aid to agricultural colleges and schools and to State and school authorities along lines of agricultural education is an item of work which has increased greatly in importance and has taken much time. The correspondence has been large; the applications for publications have been numerous, sometimes involving the sending of several thousand publications for use in school classes in a single day, and the requests for addresses at large educational gatherings and for lecturers at teachers' institutes have been far in excess of the ability of this Office to meet. The Director of the Office has addressed a number of important meetings. The expert in agricultural education has lectured at similar meetings, taken part in several important conferences, and helped to organize a number of agricultural schools and prepare courses of study for them. Through the courtesy of the Chief of the Bureau of Soils the Office was able to send Mr. H. O. Sampson, of that Bureau, to lecture for three weeks at teachers' institutes in Wisconsin, one week at a teachers' institute in Pennsylvania, and one week at a teachers' institute in Maryland on the teaching of agriculture in the public schools. Mr. Sampson's experience as a teacher of elementary agriculture in a small high school in Pennsylvania has given him good preparation for this work, and his services in the teachers' institutes were highly appreciated. He has since been transferred to this Office, and is now on furlough to engage in the experiment of starting an agricultural high school in a rural community in Maryland. It is hoped that as the educational work of the Office develops, the services of Mr. Sampson and other experts in agricultural education may be made available to assist in organizing different phases of agricultural education work in the United States, and in conducting agricultural features of instruction in summer schools and institutes for teachers.

RELATION TO FOREIGN INSTITUTIONS.

INTERNATIONAL CONGRESS OF AGRICULTURAL EDUCATION.

The proceedings of the Second International Congress of Agricultural Education have been published in two volumes. In the first volume there are reports and preliminary documents relating to the work of the four sections: (1) Higher agricultural education, (2) secondary agricultural education, (3) popular agricultural education, and (4) various means of disseminating information concerning agricultural science. In the first and third sections are given reports, opinions, and resolutions presented or adopted at seven preceding international congresses of agriculture and at the First International Congress of Agricultural Education, held at Paris in 1904. In the section on higher agricultural education thirty-five papers were presented by delegates representing fourteen countries of Europe, the United States, Japan, and the German colonies. In these papers are discussed systems of agricultural education, the work of particular agricultural institutions, agricultural courses in general, and particular phases of instruction in agriculture, such as agricultural mechanics, economic entomology, zootechny, tropical agriculture, rural economy, zoology as applied to agriculture, etc.

The papers presented at the section on secondary agricultural education differ materially from those presented at the first section, in that only one of the eleven papers discusses the work of a particular institution (the Provincial School of Agriculture, Barcelona, Spain). The other papers are taken up with discussions of the educational value of secondary courses in agriculture, desirable features of such courses, qualifications of teachers, agricultural schools for women, etc.

At the section on popular education twenty papers were presented. These discuss such topics as traveling schools, agricultural instruction in primary schools, courses for farmers, courses in agriculture for soldiers, and the service of agronomes. The papers presented at the fourth section are devoted to such subjects as reading circles, agricultural libraries, agricultural journals, lantern slides, lectures, and other means of disseminating information.

Volume 2 of the report is taken up with the proceedings of the congress.

INTERNATIONAL AGRICULTURAL INSTITUTE.

Concerning the establishment of the International Agricultural Institute at Rome a recent number of Revue Scientifique states that in spite of pessimistic predictions the future of this institute is assured, since the following countries have signified their intention to cooperate in its establishment: Italy, France, England, Russia, Germany, Austria-Hungary, United States, Japan, Belgium, Holland, Switzerland, Spain, Portugal, Denmark, Sweden, Greece, Luxemburg, Servia,

Bulgaria, Egypt, Persia, Mexico, Equador, Uruguay, Nicaragua, Cuba, and San Salvador. It is expected that, in accordance with the wish of King Victor Emanuel, the new palace in Rome will be completed in 1907, and the following year the work of the institute will commence.

INDIA

In India the work of instruction and research in agriculture is in a formative condition, but there is evidence that the government of that country is thoroughly aroused to the desirability and importance of aiding its basic industry by means of research, education of different grades, demonstration, and close contact with the farmers. At the head of the institutions for agricultural education and research will stand the Imperial Agricultural College at Pusa (to be opened in 1907), where also are located the imperial agricultural research station, an experimental farm, and a cattle breeding farm. The college is located on a government estate of 1,358 acres, and the buildings now in progress will cost considerably over a half million dollars, toward which has been applied a portion of the donation of $150,000 made by Mr. Henry Phipps, of this country, to which reference has previously been made. The organization of a staff composed of European specialists with native assistants has now been completed. The college will provide specialized post-graduate courses in the hope that the best of the native students will ultimately be fitted for the higher appointments in the imperial department. It will also provide men with a good agricultural education for employment in the regular government service, and as agents and managers for owners of estates and the like.

The institutions for agricultural education include, besides the agricultural college at Pusa, a college of agriculture in Madras, a college of science at Poona, the Imperial Foresty Research Institute and College at Dehra Dun, and agricultural schools at Sibpur (Calcutta), Cawnpur, and Nagpur. The agricultural college and research institute for Madras is now in course of erection at Coimbatore. In 1905 a grant to the presidency by the government of India of $50,000 per annum, which was subsequently increased to $100,000, added to the allotment made by the government of Madras removed all financial difficulty experienced by the Madras agricultural department. The result of this improved financial condition was the decision of the government to close the agricultural college at Saidapet and establish a new college and research institute, adequately equipped with laboratories and class rooms and with a suitable farm near Coimbatore.

The staff will consist of an expert agriculturist as the principal of the college, a superintendent of the central farm, a government botanist, and an agricultural chemist. Ultimately an entomologist and mycologist may be added. The staff will combine teaching with

research work. Problems connected with the agriculture of the Presidency will be studied in the laboratory and the field, while the students will be given a general education in all branches of agricultural science.

In order to make better provision for research work in forestry, and to secure a permanent staff of forest experts for scientific research, as well as for training candidates for the Government and State forestry service, the Imperial Forestry School at Dehra Dun, India, has been enlarged and hereafter will be known as the Imperial Forestry Research Institute and College. The college staff will include officers of the imperial service, holding the following positions: (1) Sylviculturist, who will make sylviculture his special duty; (2) superintendent of forest working plans, who will collect and collate statistics of the results of forestry management throughout India; (3) forest zoologist, who will investigate the damages caused by insects and other pests; (4) forest botanist, who will study the botany of forest plants, distribution of species, diseases of forest trees, etc.; (5) forest chemist, who will investigate the chemical properties of soils and forest produce; and (6) forest economist, who will study economic methods of commercial timber production and marketing. These officers, while engaged primarily in research work, will each deliver a course of lectures on his special subject in the college, and take part in the training of the students. The work of instruction, however, will for the most part be carried on by four assistant instructors.

It is further proposed to locate an agricultural college in each important province, with a course of technical training extending over three years. In the past the personnel of the agricultural colleges has been inadequate, so that their influence on agricultural improvement has been small. The main result of the colleges has been to turn out students with some knowledge of agriculture, who have been largely absorbed into the several branches of government revenue administration. It is believed now that the demand for graduates will be sufficient to induce a larger number of students to attend, as the field for the trained agriculturist is said to be broadening. The course in the provincial agricultural colleges will lead up to the specialized post-graduate course at Pusa.

Considerable attention will also be given to the dissemination of information, especially the results of agricultural investigation and their application in practice. Temporary demonstration plats will be started, district agricultural associations will be organized, agricultural shows will be subsidized; the distribution of improved seed, implements, and manures will be extended, and popular publications in the vernacular will be issued. It is pointed out that there are many difficulties in the way of agricultural improvement in a country like India, where most of the land is divided into small holdings and cultivated by men with no capital and little education; but by the means

enumerated it is hoped to bring the work into closer touch with the actual farmers, and make it of more immediate use to them.

ENGLAND AND WALES.

The annual report of the board of agriculture and fisheries of Great Britain contains much interesting material concerning agricultural education in that country. It consists of a general report on the work of the year, a list of grants awarded in 1904–5, and four appendixes: (1) Reports on institutions receiving grants; (2) education in rural districts—school gardens; (3) summary of the agricultural instruction provided by county councils in England and Wales in the year 1904–5; and (4) statement showing the expenditure of county councils in England and Wales upon agricultural instruction in the years 1903–4 and 1904–5.

In the general report attention is called to an increase of $4,856 in the amount given to local institutions in aid of agricultural education. One-half of this sum was awarded in two equal grants for lectureships in forestry at the University College of North Wales, Bangor, and Armstrong College, Newcastle on Tyne. The sum of $971.20 was given to aid "the excellent scheme of instruction provided by the county council of Essex at their technical laboratories in Chelmsford;" and $971.20 and $485.60, respectively, to the agricultural departments of the university colleges of Reading and Aberystwyth on account of the establishment of farms in connection with these institutions.

The statement is made that the principal reason for giving financial assistance to educational institutions was to provide facilities for training young men for the practice of agriculture, but it is considered noteworthy that a large percentage of "the best students have been attracted from the practice of agriculture by the offer of research and teaching appointments, and are now filling many of the more important chairs and lectureships" in England, as well as important positions requiring trained specialists in the colonies of Great Britain and in other parts of the world. It is recognized that "agricultural science offers to our best students a career which is certainly not less attractive than that presented by the older and more conventional professions."

A feature of the work of the different colleges, aided by the board during the past year, has been the attention given to the training of teachers for the elementary schools. Short courses, usually extending over two weeks, have been given for teachers at many of these institutions. In this work the county councils have frequently cooperated. The courses have included instruction in nature study, horticulture, economic entomology, dairying, school gardening, and other subjects of this nature. The attendance of teachers at Reading University College was 25; at Wye College, 67; at the University College of

Wales, 42; at the Midland Agricultural and Dairy Institute, 61; at Harper-Adams College, 13; and at the Essex County Technical Laboratories, 30.

In the appendix on "Education in Rural Districts—School Gardens," detailed information is compiled from replies to thirty-three questions sent by the board of agriculture and fisheries to the different county councils. These questions and answers relate to gardens connected with both day and evening schools and to the sources from which land, funds, seeds, and tools are supplied; the total area in gardens and the size of each plat; the instructors, their training and compensation; the number and ages of children doing garden work; the time devoted to this work; systems of cropping; supervision; systems of prize giving; and disposal of products. From the replies received, it appears that at least 32 counties have gardens connected with day schools, and 22 counties maintain other gardens either connected with evening schools or worked independently by boys and young men.

In the case of the day-school gardens, it appears that in most counties land and tools, and in a few counties seeds, are provided either directly or indirectly by the county councils. The seeds are usually provided by the local school authorities. The size of the gardens ranges from one-eighth to one-fourth of an acre, and the size of the individual plats from 1 to 3 square rods. Custom varies as to whether each pupil shall have a separate plat or whether the land shall be worked in common. The teachers of gardening are usually the head teachers in the schools, who in many counties are required to have credentials of qualification for this work. Sometimes gardeners are employed as instructors, though this arrangement is not very satisfactory. The ages of the pupils in gardening range from 9 to 15 years, with comparatively few less than 11 years. Two hours a week is given as the general average of time devoted to gardening.

There is no general system of cropping or prize giving, and only a few counties in which the work is under the supervision of a county instructor in horticulture, though this last is considered highly desirable. The produce in some cases becomes the property of the boys, in others it is disposed of by the school and the proceeds used for the purchase of seeds or for the benefit of the class, and in others it is taken by the teacher, though the latter practice is not commended.

The agricultural instruction provided by the different county councils is quite varied in nature. It includes aid to the agricultural departments of colleges; employment of instructors in agriculture, dairying, poultry keeping, bee keeping, and farm hygiene; the management of field experiments, experimental farms, and fruit-growing stations; and the support of classes in horseshoeing, manual training, horticulture, and school gardens, as well as the partial support of

training classes for elementary teachers. Not all of the councils carry on work in all of these subjects, but each subject receives some attention in many different counties of England and Wales.

The receipts of the county councils from the customs and excise act of 1890, as shown by this report, have decreased considerably in recent years, but notwithstanding this fact the county councils were able up to last year to increase the amounts devoted to agricultural education. The total amount received in 1903–4 was $3,369,340, and of this amount $424,764 was devoted to agricultural education in 1904–5, as follows: General expenditures, $47,997; dairy instruction, $63,512; agricultural lectures, $22,940; poultry keeping, $15,272; horseshoeing and veterinary science, $13,296; bee keeping, $5,677; horticulture, $50,818; manual processes, $6,264; miscellaneous, $19,633; scholarships, $51,240, and grants to colleges and schools, $128,597.

From other sources it is learned that a deputation recently waited upon the board of agriculture in London to urge the necessity of proper provision being made throughout the country for research and higher education in agricultural science. The deputation consisted of representatives of the universities of Cambridge, Leeds, Wales, and North Wales, Armstrong College, University College of Reading, Midland Agricultural and Dairy Institute, Harper-Adams Agricultural College, Southeastern Agricultural College, Carnarvonshire and Derbyshire County councils, and other local authorities.

It was urged that if English agriculture is to hold its own in the face of increasing foreign competition English agriculturists should be enabled to bring to their work a scientific knowledge and training in scientific methods such as are placed at the disposal of foreign rivals. Representatives of the board of agriculture expressed the fullest sympathy with the work which the colleges had done and with the object of the deputation, and indicated their readiness to lend the movement such aid as was in the power of the board.

Forestry is now coming in for considerable attention at colleges in England. At Oxford a three-year forestry course is now provided. Two years of the course are spent at the university and the third year on the Continent. Candidates for the Indian forest service are selected partly by examination held by the civil service commissioners and partly by nomination. Candidates who have taken the full course and secure appointments receive about $1,500 the first year, and the grading is such that the final salary may reach $10,000 a year. At the end of twenty-two years Indian forest officers can retire on a full pension, the maximum being about $2,500 per year.

The forestry branch of Armstrong College, Newcastle on Tyne, has been given charge of the local management of Chopwell Woods in the county of Durham. These woods are within a few miles of the col-

lege, and contain nearly 900 acres of larch, spruce, Scotch pine, oak, ash, and other trees, most of which were planted about fifty years ago. A house is being built in the woods for the college lecturer in forestry, and arrangements made for the holding of short courses for practical foresters. It is believed that this addition to the college will make it one of the most favorable centers for forestry instruction in the United Kingdom.

The Royal Agricultural College of Cirencester has instituted for its forestry students a series of annual vacation excursions to the German forests. The initial excursion included visits to the Oberförsterei of Darmstadt, the oak and pine woods of Viernheim, the large coppice in the Oldenwald now under conversion to high forests, and some of the Heidelberg woods. Shorter excursions to forest areas in England and Wales are frequent during the college year.

The board of agricultural studies at Cambridge University reports that the Worshipful Company of Drapers, to whom it is already indebted for the endowment of the chair of agriculture, has offered $25,000 toward the buildings required by the agricultural department on condition that an equal sum be raised by the end of the year. Pledges of $5,000 each have already been received from four persons.

The University College of Reading maintains a poultry farm at Theale. The farm consists of nearly 50 acres of land, and is provided with an excellent equipment, which is assembled in an incubator house, a brooder house, scratching sheds, a cramming shed, portable poultry houses, and a plucking and trussing shed. Six breeds of chickens and one of ducks are raised.

A recent description of agricultural education in Lancashire indicates that this work is well organized in nearly all its different phases. These include agricultural instruction at the Agricultural College of the Harris Institute, Preston; instruction in dairying, both at the permanent dairy school on the county council farm, Hutton, near Preston, and also by means of migratory teachers; instruction in poultry work at the poultry school on the county council farm and by means of migratory teachers; lectures on agriculture, dairying, poultry keeping, horticulture, veterinary science, and bee keeping at various centers in the county; advisory agricultural work in the county, and experimental work at the farm and elsewhere in the county.

All of the agricultural work is under the control of an agricultural subcommittee, consisting of representatives elected by the education committee of the Lancashire County council, by the council of the Harris Institute, and by the council of the Royal Lancashire Agricultural Society. The agricultural course at Harris Institute is intended to prepare young men and women for the practical work of

the farm, and extends over four years, each session beginning in September and ending about the 1st of May. Each student is not only given free instruction, but if not a holder of a junior or senior agricultural scholarship is allowed a sum not exceeding $2.40 per week by the county council. Tuition fees are required of nonresident students.

The instruction given at the dairy school, the poultry school, and by means of lectures in different parts of the county is confined to the single branch of agriculture under consideration, while the agricultural work in Harris Institute includes also instruction in chemistry, zoology, mathematics, electrical engineering, mechanical engineering, drawing, natural science, physics, surveying, and woodwork.

SCOTLAND.

In Scotland the new buildings for the Edinburgh and East of Scotland College of Agriculture were formally opened February 28 by Lord Balfour, of Burleigh. These buildings, according to Nature, are in Green Square, Edinburgh, and consist of well-equipped chemical, botanical, and bacteriological laboratories and lecture rooms, and class rooms for the various other subjects taught in the college. Their cost has amounted to more than $45,000.

IRELAND.

According to the annual report of the Department of Agriculture and Technical Instruction for Ireland, 1904–5, agricultural instruction was continued at the Royal College of Science, Dublin; the Albert Agricultural College, Glasnevin; and at Munster Institute, Cork. At the Royal College of Science 38 students were in attendance, at the Albert Agricultural College 68, and at Munster Institute 50, the latter all young women. The courses in dairying, calf rearing, poultry keeping, gardening, sewing, cooking, and laundry work at the Munster Institute are so highly appreciated that although only 50 students can be admitted, there were at the time of this report nearly 250 applicants on the waiting list of the department.

Winter agricultural schools, running from six to twenty-six weeks, were held at sixteen centers and 317 students were enrolled. Twenty itinerant instructors were at work during the year and attended a total of 1,054 meetings of farmers. A larger number would have been employed but for the difficulty of securing men of adequate training and experience. To overcome this difficulty somewhat the department held a forestry school for instructors in agriculture at Avondale Forestry Station, a poultry-fattening school at Avondale Poultry Station, and a bee-keeping school at Albert Agricultural College.

The department also offers scholarships at the Royal College of Science in Dublin and the Albert Agricultural College, Glasnevin,

each scholarship to include free tuition for one year, a third-class railway fare to and from college, and either a maintenance allowance of $5 a week if in attendance at the Royal College of Science or free board and lodging at the Albert Agricultural College. These scholarships are good for one year, but may be renewed for two or three years to enable students to complete the agricultural course. In order to assist domestic-economy students the department offers ten open scholarships and ten limited scholarships at the Irish Training School of Domestic Economy, Dublin. These scholarships will entitle the holders to free admission to the full course of training for teachers of subjects in domestic economy. Arrangements have also been made by the department for the reception of a small number of students at St. Mary's Convent of Mercy, Portumna, to pursue studies in dairying, poultry keeping, horticulture, household management, cookery, laundering, etc.

The department further announces that it is prepared to assist county committees in securing instructors in agriculture, poultry keeping, horticulture, and the management of bees, and butter making, one instructor in each subject for each county. The duties of these instructors will be to deliver courses of lectures, visit farms, conduct experiments and demonstrations; assist in teaching agricultural classes provided for by the department· correspond with farmers, and otherwise advise them.

BELGIUM.

The system of agricultural education in Belgium is described in an official document prepared by the Belgium department of agriculture for distribution at the Universal Exposition in Liège in 1905. This description includes the following classes of institutions:

(1) Colleges—the State School of Veterinary Medicine at Brussels, the Agricultural Institute at Gembloux, and the Agronomic Institute of the University of Louvain.

(2) Secondary schools, of which there are three separate agricultural schools located at Carlsbourg, La Louvière, and Huy, and sixteen agricultural schools conducted as departments of other educational institutions; courses of agronomy in royal atheneums; State schools of horticulture at Ghent and Vilvorde, and private subsidized schools of horticulture at Mons, Tournai, Liège, and Carlsbourg, and a school of practical horseshoeing at Molenbeek-St.-Jean.

(3) Agricultural schools for women, including one higher agricultural school in connection with the Institute of the Sacred Heart and Immaculate Conception at Héverlé; and ten secondary schools, located, respectively, at Bastogne, Bouchout, Brugelette, Herve, Gooreind, Gyseghem, Oosterloo, Overyssche, 'S Gravenwezel, and Virton; besides three schools having departments for women located,

respectively, at Cortemarck, Heule, and Waremme. There are also traveling dairy schools for women; and in connection with the schools at Héverlé and Overyssche, schools of cheese making.

(4) Popular instruction, including primary agricultural and horticultural trade schools (ten of which are agricultural and nine horticultural departments of other schools), and popular instruction for adults (itinerant instruction consisting of from fifteen to thirty lectures on agriculture, horseshoeing, apiculture, and other special subjects).

There are also presented the statistics of agricultural education, the service of agronomes (graduates of agricultural colleges engaged in extension work for the State), and accounts of institutions connected with agricultural educational institutions, such as botanic gardens, chemical and bacteriological institutes, analytical laboratories, experiment stations, and reading circles.

A professional sugar school was opened at St. Ghislain, Belgium, May 1, 1906, with 12 students in attendance. The course of study includes the following subjects: Physics and general chemistry; analytical and applied chemistry; sugar technology, sugar chemistry, and sugar legislation; general mechanics and industrial electricity; mathematics; sugar accounts; geometrical drawing, industrial drawing, and industrial economy. The course covers two years and leads to a diploma.

DENMARK.

The Danish school for the training and instructing of renters and laborers of both sexes, established near Ringsted in 1903, has been attended by 375 pupils in long courses and 800 pupils in short courses. The pupils are chiefly girls and farm hands from 20 to 25 years of age, who attend from five months to a year, and older persons who attend the short courses of eleven days. The land for the school (54½ acres) was donated by the town of Ringsted. The department of agriculture granted a loan of $16,170 to aid in starting the school.

The report of the trip of the Scottish commission on agriculture to Denmark, June 19–30, 1904, devotes about 14 pages to education, including a brief description of the following features of the Danish system of schools: (1) The common school system; and (2) the people's high schools, private institutions, some of which were established as early as 1845, now number 78, and are attended by about 6,000 young people of both sexes between 18 and 25 years of age. From the first these schools gave instruction in land surveying, agricultural chemistry, and other sciences underlying the practice of agriculture; but when agriculture developed and increased in importance this provision proved inadequate, and hence arose a necessity for the establishment of purely agricultural schools.

(3) The agricultural schools, which are branches from the high schools, having agriculture and the natural sciences for the principal subjects of instruction. There are now 44 of these schools, 14 maintained entirely separate from the high schools, 1 a separate dairy school, and 29 associated with high schools. Admission to these schools is limited to persons from 18 to 25 years of age who have had at least one year's experience in practical farming. A demonstration station is connected with the agricultural school at Dalum and experiment stations with those at Ascov and Lyngby.

(4) The Royal Veterinary and Agricultural Institute at Copenhagen, which enrolled during the year preceding the visit of the commission about 300 students, 130 of whom were students in agriculture proper, while the remainder were students of forestry, horticulture, land surveying, and veterinary science. State aid to the Royal Veterinary and Agricultural College amounted in 1904 to $71,780, and to experiment stations and demonstration fields to $14,550. The people's high schools and agricultural schools were also aided by the Government to the extent of $37,345.

FRANCE.

The French ministry of agriculture issued a decree December 20, 1905, establishing a professional dairy school at Surgeres (Charente-Infèrieure), under the direction of M. Dornic, director of the dairy station at that place. A winter school of agriculture has been established at Troyes (Aube). The course of study is to extend over two winter terms running from November to March. This year, however, the school did not open until January 3. A poultry husbandry school has been established at Gambais (Seine-et-Oise), and opened its doors for the first practical course of three months February 1.

A school of agriculture has been established at Hennebont (Morbihan), which is well equipped with land for demonstration purposes, orchards, domestic animals, and other agricultural material.

GERMANY.

The enrollment of students for 1905 in a number of German institutions showed a large increase over the enrollment for 1904. At the Agricultural High School in Berlin there were enrolled for the winter term 893 as compared with 865 in 1904; at the Agricultural Academy at Bonn 501 as compared with 422 in 1904, and at the University of Breslau the agricultural students number 140 as compared with 129 in 1904.

A chair of fishery and fish breeding has been established at the Agricultural High School of Berlin and will be occupied by Dr. P.

Schiemenz, director of the Müggelsee Biological Station, which now becomes a department of the Agricultural High School.

An agricultural winter school was opened December 1, 1905, at Seelow, under the direction of Doctor Weiss.

The first agricultural continuation school in the Province of Brandenburg, Germany, was opened at Jessern November, 1905, and continued until the end of March. Fourteen students were in attendance, and the high grades which they maintained in the examinations at the close of the term indicated that the experiment was entirely successful. The subjects taught were chemistry, soils, fertilizers, and feeding. It is planned to supplement the winter courses by Sunday afternoon lectures during the summer months, and to keep some oversight of the students in their practical work at home. The school was opened at the request of sons of property owners in Jessern and Goyatz, who also bore the cost of instruction.

AUSTRIA.

In Austria a people's high school, similar to the people's high schools in Denmark, is maintained at Otterbach, near Schärding, by George Wieninger, president of the local agricultural society, who meets all expenses of the institution except the salaries of nonresident lecturers, which are paid by the State. The equipment of the school includes a model farm, museum of agricultural, natural science, and ethnographic specimens, a large auditorium, and a library. Free lectures and demonstrations have been given since 1845, and since 1890 thirty-two of these have been given each year. These lectures and demonstrations are given on Sunday and are attended annually by from 3,000 to 4,000 farmers and farmers' sons who can not attend school. The object of the lectures is to assist in the general instruction of the rural population and to diffuse special knowledge concerning modern agricultural methods. Those who attend 100 lectures receive a diploma; those who attend 200, a silver medal, and those who attend 300, a gold medal. Lectures are given on potatoes, fertilizers, forestry, science, and agriculture, diseases of digestive organs, the herd book in animal husbandry, sugar as food, etc. In addition to these Sunday lectures short courses of from one to two weeks are offered in feeding, distilling, bookkeeping, poultry culture, dairying, and in normal work for teachers.

A meadow culture school was opened at Eger November 1, 1906, which is temporarily in charge of Franz Lindner, director of the agricultural school at Eger.

HUNGARY.

New regulations for the Royal Hungarian Horticultural School at Budapest provide that only applicants 20 years old or more, who have

finished the sixth grade in public schools and have had one year of practical experience in gardening, can be admitted. Among the technical subjects taught in the course are garden architecture, machines and implements, landscape gardening, garden management, agriculture, farm economics, and farm law.

The Agricultural Academy at Magyar-Ovar is so crowded that it is recommending students to go to other agricultural academies in Hungary where the qualifications for admission to the Magyar-Ovar Academy will admit them to the second year.

AUSTRALIA AND NEW ZEALAND.

The Queensland, Australia, department of agriculture has inaugurated a system whereby young men who find it impracticable to attend the Agricultural College at Gatton are given the opportunity of gaining an insight into farming at the Hermitage State Farm, Warwick.

The New Zealand department of agriculture is encouraging the introduction of agriculture into the primary schools of that country. The biologist of the department has been conducting experiments for several years in connection with the Mauriceville West Primary School in teaching the elements of agricultural science and school gardening. In his report on the school-garden work, he says: "The time allotted to this work is two hours per week, and it has been found that not only does it not interfere with the effective teaching of other subjects, but it is actually an assistance, providing, as it does, additional subjects for composition exercises, increasing the pupil's powers of observation and inculcating habits of neatness and methodical arrangement."

SOUTH AFRICA.

In Natal, South Africa, the Cedara School of Agriculture, which was opened to students in the spring of 1906, provides a two-year practical course in which students spend about four days a week in practical work in the field and workshop, and the remainder of the time in the study of such subjects as forestry, horticulture, dairying, veterinary science, entomology, agricultural chemistry, mathematics, bookkeeping, and surveying. The school is provided with a new building containing two stories and a basement, the latter devoted to laboratories, kitchen, etc., the first floor to dining hall, library, and offices, and the second floor to dormitories and a large lecture hall.

A farmers' reading course in practical agriculture for the farmers of South Africa is to be given under the supervision of William P. Brooks, director of the Massachusetts Station. The course will be covered in Brooks' Agriculture, Volumes I and II, and the student will be guided in his studies by a large syllabus of over 60 pages, containing lesson assignments, helpful suggestions, directions for experiments, and over 2,000 questions on the lessons.

The government of Cape Colony is establishing the South African School of Forestry at Tokai, to provide a course of instruction for training young men for practical and scientific work in South African forestry. Provision is being made for ten resident students at Tokai, who will be received from the South African College and other similarly equipped institutions in the colony after having completed the theoretical work in forestry.

The Botanical and Agricultural Department of the Gold Coast provides annually an elementary course in theoretical and practical agriculture at the Aburi Garden to train teachers in agriculture for the public schools. The department also maintains apprenticeships to prepare young men for subordinate positions in the department or for overseers of farms and plantations.

BOLIVIA.

The Bolivian ministry of colonies and agriculture has issued an elementary text-book of agriculture for the primary schools of that country. It contains chapters on the nature of soils, preparation of soils, tillage experiments, influence of climate, irrigation and fertilizers, seed time and harvest, cereals, legumes, root crops, forage plants, textile plants, sugar plants, dye plants, oil-producing and aromatic plants, arboriculture, zootechny and breeding, and agricultural machinery. The last two subjects are treated with great brevity, occupying only two and one-half pages of the pamphlet.

BRITISH WEST INDIES.

Instruction in agriculture in Antigua, British West Indies, includes lessons at the grammar school in agricultural science and practical work in the school garden. It is claimed that pupils pursuing such a course are able upon leaving school to deal much more intelligently and successfully with agricultural problems than those who have no such training. Attention is also given at the grammar school to the training of teachers for giving some instruction in agricultural subjects in the elementary schools. With this object in view courses of lectures on the elements of plant physiology and on tropical hygiene have been given to the teachers of the elementary schools of the island and to the students of a female training college in Antigua. The importance of school garden work is also emphasized. At the present time 72 boys are taking the work in agricultural science and 40 teachers are pursuing the training courses.

CANADA.

Sir William Macdonald, who established Macdonald College at St. Anne de Bellevue, near Montreal, has deeded the property to McGill University and provided an endowment of $2,000,000, besides

the plant. A main building, buildings for agriculture and horticulture, for chemistry and physics, for biology and bacteriology, are in process of construction, together with a boys' and a girls' building, a horticultural barn, and a power house.

All of the buildings are substantially built of brick, iron, and concrete, with partitions of fireproof hollow tile and floors of concrete with wood laid on top in certain of the rooms. The walls are lined inside with hollow tiles, so as to give a dead air space. The construction is very thorough in every respect. The buildings are to be heated from a central heating plant, with a comprehensive ventilating system. Several of them are connected by underground passages, to be used in bad weather. It is expected that the buildings will be ready for occupancy in the fall of 1907. They will provide accommodations for about 400 pupils—175 men and 225 women. The school has a farm of about 560 acres, a part of which is in cultivation. One of the farms purchased was provided with large barns for cattle, and considerable stock is being kept there. The college will have a large poultry plant and extensive rooms for showing agricultural machinery.

In addition to training boys and girls for farm life, a regular normal department will be conducted for the training of teachers, with a special view to providing persons suited to teaching elementary agriculture, nature study, and the like. Although affiliated with McGill University, the faculty of the college will dictate as to the courses except such as lead to degrees.

EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The twentieth annual convention of this association was held at Baton Rouge, La., November 14–16, 1906. President M. H. Buckham in his annual presidential address made a plea for placing greater emphasis upon the liberal and "humanistic" culture studies in the curriculum, as a means of preventing narrowness and crudeness of thought and character. Such training, it was believed, should take the form of instruction in foreign languages, literature, history, economics, philosophy, and especially ethics and religion.

Even though the function of the land-grant colleges is to produce industrial experts, the speaker held that they should graduate liberally educated experts, men who know one subject thoroughly and many fundamentally. "The great problem of the higher education now before us is how to integrate specialism with the totality of which it is a part;" and each college was urged to see that its strongest emphasis is put "upon what in any and every educational institution is its main object and should be its highest ambition and satisfaction and glory—its human output."

The report of the bibliographer, Dr. A. C. True, consisted of a list of books written by agricultural college and experiment station officers. The list included 385 titles of books, the work of 195 men and women now or at one time connected with agricultural colleges and experiment stations. Books on practically all phases of agriculture and allied sciences were represented in the list, showing the large and creditable contributions of the colleges and stations of this country to the literature of scientific agriculture in its more finished and permanent form.

The committee on instruction in agriculture presented a short report through its chairman, Dr. A. C. True. A series of illustrative exercises, covering the general principles of the subject of agronomy, is being published by the Office of Experiment Stations, and will be followed by similar publications covering other branches of agriculture.

The committee has organized subcommittees on secondary courses, on courses in home economics, and on courses in rural engineering. The subcommittee on secondary courses has in preparation a syllabus of a course for use in the regular public high schools, and a series of lessons and practicums showing more fully the character and scope of this course, which it is expected will be published through the Office of Experiment Stations. The subcommittees on courses in rural engineering and on home economics have been engaged in studying the existing status of such courses in the land-grant colleges as a preliminary.

The report of this committee was followed by a lengthy discussion in which the interest of the association in this work was brought out, and its desire for the early publication of the results of the committee's studies for use in connection with various grades of agricultural instruction was expressed.

The report of the committee on graduate study was presented by Director L. H. Bailey (see Graduate School of Agriculture, p. 236).

The report of the committee on extension work was presented by President K. L. Butterfield. This report defined extension teaching in agriculture, and grouped the various forms of extension work under six heads. The main part of the report consisted of a summary of the present status of agricultural extension teaching in this country, on the basis of a circular letter which was widely sent out. The committee recommended that each college establish as soon as practicable a department of extension teaching in agriculture, coordinate with other divisions of the agricultural work and in charge of a competent director, and that pending such action a faculty committee be maintained to study the problem.

A more extended account of the work of this committee is given in the report of the Farmers' Institute Specialist of this Office (p. 314),

who at the request of the chairman of the committee was designated to act as secretary of the committee.

Mr. L. A. Kalbach, representing the Commissioner of Education, gave a paper showing the relation of the Bureau of Education to the land-grant colleges and the growth of these institutions during the past ten years.

The association placed itself on record as strongly in favor of adequate appropriations to the Office of Experiment Stations to enable it to enlarge its work upon agricultural education, the details of the various forms of agricultural extension teaching, and to assist the different institutions to organize this form of work; and of increased Federal appropriation for education in agriculture and mechanic arts along the lines of the appropriation under the second Morrill Act. The executive committee was instructed to consider the advisability of the association meeting at least once in four years in connection with the National Educational Association.

The section on college work and administration considered three main topics: (1) Administration of the land-grant colleges—organization and classification of the instructional force, control of student activities, and student labor; (2) relation of the land-grant college to the public school system, to the agricultural industries, and to the mechanical industries, and (3) curriculum of the land-grant college—study of home economics in the land-grant college, the short practical course, its place and importance, and agricultural extension.

J. L. Snyder, of Michigan, discussed the organization and classification of the instruction force, and E. B. Andrews, of Nebraska, the control of student activities, including such matters as students' finances, athletics, and social functions. R. W. Stimson, of Connecticut, read a paper on student labor, in which he reviewed the history of this phase of college work and noted an unmistakable tendency toward labor for educational exercise rather than for the production of a finished product. D. B. Purinton, of West Virginia, B. O. Aylesworth, of Colorado, and others, discussed the relation of the land-grant college to the public school system, the discussion bringing out the fact that the colleges generally are confronted with demands for assistance from the public schools, and owe a duty to these schools largely in the direction of helping them to develop courses related to the occupations of the people in rural communities. W. A. Henry, of Wisconsin, discussed the relation of the land-grant college to the agricultural industries, and developed a strong argument for the definite organization of extension departments in these colleges. This was further emphasized by J. C. Hardy, of Mississippi. The relation of the land-grant college to the mechanical industries was treated by A. B. Storms, of Iowa, in a paper dealing largely with the work begun and proposed by the engineering experiment station of

Iowa College. Miss Isabel Bevier, of Illinois, talked on the subject of home economics in the land-grant college, approaching the subject from the standpoint of the home and its needs. She stated that the development of suitable courses of home economics is limited at the present time only by the resources of the institution, the ability, tact, skill, and wisdom of the people in charge of the work, and the attitude of mind of colaborers in the institution.

THE GRADUATE SCHOOL OF AGRICULTURE.

The second session of the Graduate School of Agriculture was held at the college of agriculture of the University of Illinois, July 2–28, 1906. Dr. A. C. True, Director of the Office of Experiment Stations of the United States Department of Agriculture, was again selected as dean of the school, and Prof. Eugene Davenport, dean of the college of agriculture of the University of Illinois, acted as registrar.

The opening exercises of the school were held on the evening of July 4, when the school was welcomed to the university by Dr. T. J. Burrill, vice-president of the university. Prof. L. H. Bailey presided and made an address in which he pointed out the need of a comprehensive system of agricultural education comprising institutions or departments for research, graduate study, college courses, extension work, and secondary and elementary courses. The graduate school is needed to aid in the more complete establishment of such a system and to stimulate workers in our agricultural institutions to more thorough study and research.

A paper by Dr. H. W. Wiley, Chief of the Bureau of Chemistry of the United States Department of Agriculture, was also presented, in which the meager opportunities for study along agricultural lines in preparation for the doctor's degree at our leading universities were shown. These were contrasted with the wider opportunities for such work offered in the German universities and the greater extent to which advanced study in agricultural lines is encouraged. Doctor Wiley declared that "there are no problems of a strictly scientific character which at the present time have more intimate relations to the welfare of the people than those which are connected with agriculture. The field of research also in this region is more fruitful, the number of problems greater, and the opportunities for discovery wider than in almost any other field of scientific investigation. The establishment of agricultural colleges and experiment stations is giving proper training to a vast body of young men, many of whom ought to enter the university and continue the studies of their college days. * * * What the friends of agriculture should ask is that in the future our great universities should recognize agricultural science as one of the leading branches to which attention should be paid in graduate studies."

Dr. A. C. True gave a short history of the graduate school and pointed out the great development of agricultural education and research in this country since the first session of the school was held four years ago. The following statements are taken from his address:

THE GRADUATE SCHOOL OF AGRICULTURE—PAST AND PRESENT.

The Graduate School of Agriculture originated in the mind of Prof. Thomas F. Hunt, then dean of the college of agriculture of the Ohio State University. His plan for such a school received the cordial approval of the president of the university, Dr. W. O. Thompson, and on the recommendation of these two men the board of trustees of the university took action in April, 1900, in favor of the establishment of the school and generously made provision for its financial support. The plan for this school was presented by the president of the university to the Association of American Agricultural Colleges and Experiment Stations at its annual convention in November, 1900, when the matter was referred to its executive committee. At the convention of 1901 this committee reported favorably on the plan and recommended that if the success of the session seemed to justify the continuance of the school, it be made a cooperative enterprise under the control of the association. This action of the executive committee was indorsed by the association. The Secretary of Agriculture, Hon. James Wilson, also expressed his cordial approval of the movement for the establishment of this school, and, acting on his advice, the Director of the Office of Experiment Stations consented to act as dean, and other officers of the Department became members of its faculty.

The first session of the school was held during the month of July, 1902, in Townshend Hall, the substantial and well-equipped agricultural building of the Ohio State University, where were illustrated the most improved apparatus for instruction in soil physics, dairying, and other agricultural subjects. Besides the live stock of the university farm, leading breeders of Ohio furnished choice animals for the stock-judging exercises.

Courses were offered in agronomy, zootechny, dairying, and breeding of plants and animals. General problems of agricultural science and pedagogy were discussed at the inaugural exercises and at Saturday morning conferences. Among the topics thus treated were the history of agricultural education and research in the United States, the organization of agricultural education in colleges, secondary schools, nature-study courses, correspondence courses, farmers' institutes, and various forms of university extension, what constitutes a science of agriculture, methods and value of cooperative experiments. Through social assemblies, visits to typical Ohio farms, and much

informal discussion wherever the students met together, the educational influences of the school were greatly extended.

The faculty consisted of 35 men, of whom 26 were professors in agricultural colleges, 7 were leading officers and experts of the United States Department of Agriculture, and 2 were officers of the New York State Experiment Station.

Seventy-five students were in attendance. These were drawn from 28 States and Territories, including such widely separated regions as Maine, Oregon, California, New Mexico, and Alabama. There was one student from Canada and one from Argentina. There was also one woman, and the colored race was represented by teachers from the Tuskegee Institute and the agricultural college at Greensboro, N. C. Twenty-seven of the students were professors or assistant professors in the agricultural colleges, 31 were assistants in the agricultural colleges and experiment stations, 9 were recent college graduates, and 8 were engaged in farming.

The success of this first session was so marked that the continuance of the school was deemed advisable, but various causes have prevented the holding of the second session until the present year. At the convention of the Association of American Agricultural Colleges and Experiment Stations held at Washington, D. C., in November, 1905, the association voted to assume responsibility for the graduate school and committed its management to the standing committee on graduate study. This committee promptly accepted the invitation of the trustees and president of the University of Illinois to hold the second session here and took measures for the organization of a faculty and programme.

The honorable Secretary of Agriculture again expressed his intention to cooperate cordially in furthering the interests of the school. Acting on his advice and at the invitation of the committee on graduate study, the Director of the Office of Experiment Stations consented to act again as its dean, and to assemble a faculty. The dean of the college of agriculture at the University of Illinois consented to act as registrar, and as the representative of the university has attended to all the local arrangements for the school, its advertising, and the registration of students.

Under present conditions, therefore, the Graduate School of Agriculture is truly a national institution conducted by the Association of American Agricultural Colleges and Experiment Stations, but with the cooperation for this second session of the Department of Agriculture and the University of Illinois. Its board of management is the committee on graduate study of the association, consisting of Prof. L. H. Bailey, of Cornell University, New York, chairman; Dr. H. P. Armsby, of State College, Pennsylvania; President M. H. Buckham, of the University of Vermont; President R. H. Jesse, of the

University of Missouri; President W. O. Thompson, of Ohio State University, and President Brown Ayres, of the University of Tennessee.

The school is supported by the voluntary contributions of some thirty of the colleges included in the association, by matriculation fees, and by funds granted for this session by the board of trustees of the University of Illinois. The university also freely gives the school the use of its buildings and equipment, and the services of its officers, including especially members of the staff of the agricultural college and experiment station. The faculty has been gathered from the United States Department of Agriculture, the University of Illinois, and other universities and colleges in some twenty States.

Since the duration of the session is short and the funds of the school are limited, no attempt has been made at either session to offer courses in all branches of agriculture. The plan on which the school is organized contemplates the holding of different sessions at different institutions. It has heretofore been thought well to take advantage at each session of the special facilities afforded by the institution at which that session is held. At Ohio State University courses were therefore given, as stated above, in agronomy, plant and animal breeding, zootechny, and dairying. At the present session courses will be given in agronomy, horticulture, plant and animal breeding, and zootechny. Special stress will be laid here on matters relating to the culture of plants adapted to the Mississippi Valley and the Great Plains, and the production of animals for beef.

Whatever the agricultural college and experiment station of the University of Illinois has to offer to advanced students along these lines will, it is hoped, be utilized to its fullest extent by the members of this school. And we shall hope also to derive much of inspiration and profit from the environment of this university and the great agricultural State in which it is located.

As stated in its prospectus, "the purpose of the Graduate School of Agriculture is to give advanced instruction in the science of agriculture, with special reference to the methods of investigating agricultural problems and teaching agricultural subjects." It is expected that the grade of instruction will be thoroughly postgraduate, and no attempt will be made to meet the needs of undergraduates or popular audiences. As a rule it is expected, therefore, that the students will have at least completed a college course and taken a bachelor's degree, but all persons will be admitted to the privileges of the school who bring convincing evidence of their fitness to engage in its work.

Meeting in the halls of this great university, we expect to conform to the professional and ethical code, which, though unwritten, is binding on all teachers and students in a graduate school in any

branch of human learning. This code, we take it, is briefly comprehended in a few principles, among which are absolute adherence to truth as each man sees it, perfect freedom of opinion and utterance within the bounds of decency and common sense, and individual responsibility and credit for whatever of new thought each man can justly claim as his own. Within these limits we care not how many different or apparently conflicting theories or interpretations of fact may be offered here. In the arena of debate there is to be a free field and no favor. We hope the intellectual tilting here will be as serious and earnest as were the combats of mailed horsemen in the days when "knighthood was in flower" and men's lives were at hazard in the tournaments. But afterwards may there be a real truce of God, with Truth in full possession of the field.

The time is too short to expect systematic courses of instruction, but there should be opportunity for the discussion of many points along advanced lines where there is yet room for more than one conclusion, the suggestion of new problems for investigation, the revealing of better methods of research and instruction. We shall hope to consider also to a certain extent some of the broader problems connected with the more definite formulation of a science of agriculture and the more effective organization of an American system of agricultural education and research.

In taking up the work of this session of the Graduate School of Agriculture it is well for us briefly to review the past and to consider the present status of the movement for agricultural education in this country. Our agricultural colleges have already begun to celebrate their semicentennials, though it will not be until next year that the first one actually to open its doors to students—the Michigan Agricultural College—will have rounded out a full fifty years of operation. Much time was spent in getting these institutions into effective running order, and for many years agricultural instruction went little further than the teaching of the sciences related to agriculture. Then came the establishment of the agricultural experiment stations as departments of these colleges, and for more than a decade the chief emphasis was laid on the work of the stations as discoverers of new knowledge and purveyors of information to the farmers.

Thus it came about that the twentieth century opened before the agricultural colleges realized in any broad way that there was a real science of agriculture on which could be based a comprehensive system of agricultural education and research. Only a few of our colleges had opened their eyes to the fact that largely through the work of the experiment stations and the Department of Agriculture a new science had been created when the first session of the graduate school was opened in 1902. The movement for the reorganization of these colleges on the basis of agriculture itself had only begun. The professor

of agriculture was in many institutions still the lone representative of the great science and industry, which as a subject of college instruction should be divided into many branches, each worthy of the undivided attention and best energies of first-class specialists. The equipment of these colleges in agricultural lines was equally meager, and it was thought a remarkable thing at that time that the universities of Ohio and Illinois had just erected agricultural buildings which in size and architecture compared well with those devoted to natural science, engineering, and the so-called humanities. It was natural, therefore, that at the first session of the graduate school much stress should be laid on the formulation of a science of agriculture, on specialization in teaching and research in agricultural lines, and on the need of adequate equipment in the way of buildings, apparatus, illustrative material, etc.

It is of course impracticable to measure the influence of this school on the progress of the movement for the betterment of agricultural education in this country, but it is believed that it has been an influential factor in promoting this cause.

Statistics showing the development of our agricultural colleges during the past five years are necessarily incomplete, and may in some respects be misleading, but some of them are interesting and significant. In 1901 it was reported that the number of agronomists in these colleges was 3; in 1905 there were 42; in 1901 there were 21 animal husbandmen, and in 1905 there were 62; in 1901 there were 2 poultry husbandmen, and in 1905 there were 9; in 1901 there were 57 dairymen, and in 1905 there were 58; in 1901 there were 3 rural engineers, and in 1905 there were 15; in 1901 there were 8 foresters, and in 1905 there were 18; in 1901 there were 71 horticulturists, and in 1905 there were 83.

In the field of rural economics in 1901 there was a lecturer in farm law at the Massachusetts Agricultural College and an instructor in farm accounts and business methods at the Connecticut Agricultural College; in 1905 there were, in addition to these, an instructor in accounts and a professor of farm mathematics at the Minnesota Agricultural College; professors of rural economics at the Nebraska, New York, and Ohio colleges of Agriculture, a professor of rural sociology at the Rhode Island Agricultural College, and a professor of irrigation law at the Colorado Agricultural College.

In 1901 extension work was recognized in five institutions by seven officers who gave a portion or in some cases all of their time to this work; in 1905 nine institutions had definitely organized extension departments manned by nineteen officers.

In material equipment the agricultural colleges and experiment stations have made remarkable gains since the first session of this

graduate school in 1902. Progress in this direction has affected the institutions in all parts of the country. Only a few of the more notable buildings recently erected will be mentioned here. Wisconsin has completed an agricultural building costing $175,000; South Carolina one costing $50,000; North Carolina one costing $100,000; Nebraska one costing $65,000; Kansas and Mississippi have put up large science buildings corresponding in general uses to agricultural buildings. New York is now putting $250,000 into an agricultural building at Cornell University, and Pennsylvania has erected a splendid dairy building which is to form one wing of a large agricultural building, the completion of which will involve the expenditure of $150,000 more; Virginia is constructing agricultural buildings costing $165,000; Idaho, $60,000. Many special laboratory buildings have been erected. For example, at the Iowa State College a farm mechanics building, a two-story judging pavilion for agronomy and animal husbandry, and a $60,000 dairy building; in Kansas a dairy building; in Massachusetts a $40,000 horticultural building; in Michigan a $30,000 bacteriological laboratory; in Minnesota a live-stock building combining judging pavilion, offices, class rooms, and stables; in Nebraska a farm engineering building and a creamery building. Here in Illinois the great agricultural building completed six years ago is now being remodeled to provide larger class rooms and laboratories to accommodate the increased number of students; special buildings for work in agronomy, horticulture, and animal husbandry have been erected and a farm mechanics' building is being constructed. In Arkansas where the State University has been slow to recognize the claims of agriculture a college of agriculture has been organized this year and substantial buildings for general agriculture and dairying have been erected on the university campus. Seventeen years ago Oklahoma was opened to settlement and is now admitted to Statehood. In that period a strong agricultural college and experiment station has been built up and, in addition to other good buildings, a special agricultural building costing $65,000 is nearing completion. In order to have the head of the institution in the right environment, the president's offices have been located in this building.

Since coming here I have received a note from President Wheeler, of the University of California, in which he says: "We have received a bequest of 5,500 acres of superb land near Fresno from Theodore Kearney, altogether worth, deducting all encumbrances, not less than $750,000. This is for agricultural experimentation. The field is a great one and worthy the best talent." I know some institutions that would take their chances with an earthquake if a thing like this would follow in its wake.

The courses of instruction in agriculture in many institutions have been greatly broadened and strengthened. The requirements for admission and graduation in four-year courses have been raised; more ample provision for short courses has been made and these courses in a number of States have been surprisingly popular; graduate courses in agriculture leading to a master's degree are now offered in thirty-five States and agricultural studies are recognized as appropriate for candidates for the degree of doctor of philosophy in seven States.

During the past four years research work in agriculture has also made great advances. The funds available for this work have been greatly augmented. In the United States Department of Agriculture the funds devoted to research have more than doubled; the States have greatly increased their appropriations to the experiment stations, so that last year the income of the stations from sources within the States was greater than that derived from the Federal Government under the Hatch Act, and on March 16 of the present year (1906) Congress passed the Adams Act, which immediately adds $240,000 to the income of the stations, an amount to be increased by $96,000 each year for five years, after which it will continue annually to the aggregate amount of $720,000. The stations have greatly extended their work and their influences in many directions. On one side they are touching more closely and fully than ever before the varied practical interests of the farmers through their publications and through cooperative and demonstration experiments in numerous localities; on the other side they are increasing and strengthening their more elaborate scientific and original researches into the real nature and causes of agricultural problems. And it is a notable indication of the wide public appreciation of the importance of thoroughly scientific investigations in behalf of agriculture that Congress has limited work under the Adams Act to original research in agriculture.

Meanwhile the movement for popular agricultural education has made rapid strides. The farmers' institutes have spread out to every State and Territory and even to our possessions beyond the seas, and the attendance was increased last year by over 150,000 persons. Secondary schools of agriculture have been organized in a number of States. The teaching of elementary agriculture in the public schools is now authorized by law in over thirty States. Teachers in large numbers are studying agriculture in agricultural colleges and normal schools. The problems of agricultural education are now seriously discussed in the National Educational Association, and in State, county, and local teachers' associations and institutes throughout the land.

This second session of the Graduate School of Agriculture is, therefore, held at a very interesting and important juncture in the history

of agricultural education in the United States. The long struggle for the adequate recognition of agriculture in colleges and universities is essentially won. The influence of our leading agricultural institutions is now being felt in every quarter of our land. A healthful competition to secure the best men and facilities for agricultural instruction and research is rapidly spreading among the States. A narrow and illiberal policy toward agriculture on the part of college authorities is now possible only where college trustees and presidents do not often get beyond their own dooryard. College professors who do not recognize the validity of the claims of agriculture to good standing in college and university programmes thereby proclaim themselves mossbacks.

The effort for the introduction of agriculture into the public schools has reached the point where educators generally admit the importance and desirability of such an enrichment of school programmes. The great body of school officers and teachers is rapidly awakening to the fact that the ideals of education have actually so far changed that studies in nature and the industries are now to be considered essential parts of primary and secondary education, and that if this is so agriculture in some form must be brought into the public schools in both rural and urban communities. The questions which remain to be answered relate to the details of carrying out the conceded principles, including such matters as the extent of agricultural instruction in secondary and primary schools, methods of teaching, preparation of teachers, etc.

The rapid growth of popular appreciation of the value and importance of agricultural education and research is putting a heavy responsibility on the leaders of agricultural progress in this country. It is no longer so much a question of stimulating public interest in agricultural education as of guiding a rapidly accumulating public opinion along the safest and most beneficial lines. The friends of agricultural education and research have aroused popular expectations to a high pitch. The most important question now is, Can they meet these expectations? Will it be possible to secure and maintain an adequate supply of well-trained and efficient leaders and workers in this great cause? Some recent events have reminded us painfully that the older generation of leaders, the men who in large measure have made the science of agriculture, and given agricultural institutions their present form, is even now beginning to pass away. Can we be assured that their equals or superiors will be found to lead the divisions of the much greater army of agricultural progress in the days to come? With the development of the science of agriculture and its practical applications, leadership in agriculture is a much more specialized pursuit than it has been in

the past. These are some of the classes of agricultural leaders which our age demands:

(1) Men capable of organizing and managing large and complex agricultural institutions, such as the National and State departments of agriculture, agricultural colleges, and experiment stations.

(2) Agricultural scientists capable of inaugurating and conducting the higher research.

(3) Men combining scientific accuracy with practical judgment and thus able to conduct experiments of a more practical character.

(4) Men and women combining scientific and practical knowledge of agriculture with pedagogical knowledge and aptitude to formulate and conduct agricultural courses in colleges and schools.

(5) Men combining scientific and practical knowledge of agriculture with ability to attract and instruct adult farmers and others in popular assemblies.

(6) Men combining scientific and practical knowledge of agriculture with business ability which will enable them to achieve success as progressive farmers and farm managers.

Turning from the workers to the subject-matter on which they work, we find a host of general and special problems pressing for solution. Leaving to specialists in the graduate school and elsewhere the consideration of particular topics, we may appropriately call attention to a few of the general matters in regard to which this school should have somewhat to say. In agricultural research, for example, there is just now urgent need of a clear definition of the problems requiring investigation. This has been brought out in a striking way in the correspondence which the Office of Experiment Stations has recently had regarding lines of work which may be appropriately conducted under the Adams Act. In many instances the plans of work presented not only fail to make any clear distinction between original research and verification or demonstration, but also do not set forth in a definite way the nature and scope of the problems, the solution of which is projected. This is not strange. The science of agriculture is new and President Woodward of the Carnegie Institution, who is having much experience in such matters, tells us that the newer the science the less sharply defined are its problems. For this reason while the Carnegie Institution has had little difficulty in securing definite proposals for work in old sciences, such as astronomy and physics, it has had much trouble in determining what ought to be done in new sciences, such as anthropology. But if this is so, it does not relieve the workers in the newer sciences from the obligation to study deeply the nature of the subjects on which they are working and to make serious efforts to define the problems which they propose to investigate. Unless the work of research has a definite aim it is most likely to miss the mark.

There is also great need of the institution of more studies which will seek to determine causes and general principles or which will have for their aim the improvement of methods and apparatus.

In agricultural education much remains to be done to perfect the pedagogic form of courses of instruction, to devise better methods of instruction, and to prepare suitable apparatus, text-books, manuals, and illustrative material. In such subjects as rural engineering and rural economics and sociology almost the whole pedagogic system remains to be worked out.

This graduate school seeks to impart a helpful stimulus to the whole movement for agricultural education and research. While systematic courses of instruction can not be given, the meeting together for a month of a considerable number of our leading and mature agricultural investigators, teachers, and experts with the most active college and station workers of the rising generation gives an unequaled opportunity for the formal and informal discussion of the principles and methods of work in agricultural science, as well as of the ways and means for promoting the general cause of agricultural education. Our experience at Columbus shows that the waves of thought and action set in motion at the graduate school go out in ever widening circles and usefully agitate even the outermost boundaries of our great and growing system of agricultural bureaus, experiment stations, colleges, and schools.

The second session of this school is held under most auspicious circumstances. Not only is the local environment delightful and inspiring but the conditions prevailing in the great industry on whose behalf our efforts are made are also very encouraging. American agriculture is enjoying unprecedented prosperity, and under competent leadership this prosperity bids fair to be permanent. Bright and capable men are awakening to the fact that in agriculture is to be found (1) the best chance for individual initiative in business and (2) a good opportunity for the profitable use of capital on a reasonably large scale. High land values require better business methods and more intelligent and scientific practice. The relative scarcity of farm labor is compelling landowners to study more carefully the best methods of utilizing their land. Increase in farm values is producing great interest in the reclamation of land by irrigation, drainage, and better tillage. Public interest is more widespread than ever before in plans for the betterment of agricultural conditions, the proper adjustment of population to the land, and hygienic methods of preparing food supplies for consumption.

There is on all sides a growing sense of the importance to the public health and welfare of the preservation of our forests, the utilization of our deserts, the drainage of our swamps, the maintaining of high productiveness of our arable lands, the cleaning and adornment of

our villages and cities, the beautification of our homes. Good farming, horticulture, landscape gardening, and forestry, i. e., agriculture in some of its various branches, is more and more attracting the attention of dwellers in both country and city and becoming in some measure the pursuit or the desire of all our people. Our agricultural institutions are therefore justly regarded as the helpful agents of our whole nation and not merely as the promoters of the interests of a special class. The influences that proceed from this graduate school may well then be of interest to all classes of our people, and we who work here may well congratulate ourselves because we are dealing with matters now generally recognized as of fundamental importance to this great country, the anniversary of whose birth we are celebrating to-day.

WORK OF THE SECOND SESSION OF THE SCHOOL.

The faculty of the second session of the Graduate School of Agriculture consisted of 35 of our leading agricultural teachers and investigators, including five officers of the United States Department of Agriculture, twelve members of the faculty of the college of agriculture of the University of Illinois, and eighteen professors and experts from sixteen other agricultural colleges and experiment stations. Aside from these, there were several outside men who lectured at the school, among whom were the statistician of the Union Stock Yards at Chicago, representatives of a large commission house in Chicago and of Swift & Co., Maj. David Castleman, who spoke on the breeding of saddle horses, and Mr. N. H. Gentry, the famous breeder of Berkshire pigs.

The total enrollment of the school was 131, of whom 91 were classed as students. These came from thirty-four States and Territories. Hungary was represented by a professor from the University of Budapest, and there were three students from India. In addition, there were a considerable number of persons who came as visitors, to attend the exercises for a few days, who were not registered. The attendance, therefore, considerably exceeded that of the previous session, at Ohio State University, at which 75 students were registered.

The total expense of holding the session was $3,168.15. Toward this the colleges contributed $950, less $127.48 for traveling expenses of the graduate committee, and the university collected $710 in fees. This left a net balance standing against the University of Illinois of $1,635.63 as its contribution to the undertaking.

Courses were given in agronomy, horticulture, plant physiology and pathology, zootechny, and plant and animal breeding, with special reference to the production of plants and animals suited to the

conditions in the Mississippi Valley and the Great Plains. These included lectures and seminars, but no laboratory exercises.

Several conferences and informal meetings were held during the session of the school, and a National Association of Dairy Instructors and Investigators was formed. A conference for the discussion of general questions relating to the organization of agricultural education and research was held July 7. Dean Davenport outlined the organization of the college of agriculture of the University of Illinois. The system followed there involves the division of authority and work in such a manner that definite responsibility is laid on officers in the several departments and full credit is given for each man's share in the work. Questions involving "team work" are discussed at meetings of the workers, and every effort is made to secure full agreement on plans before their execution is attempted. In order to secure financial and moral support for the college and station the farmers' organizations throughout the State are taken into confidence, and the responsibility for the proper maintenance of the institution is laid on their shoulders.

Professor Bailey argued in favor of the establishment of regular provision for agricultural studies leading to the doctor's degree in our universities and would make this a matter to be controlled by the university rather than by the college of agriculture. He also favored the simplification of degrees and would have Ph. D., M. S., and B. S. (or M. A. and B. A.) the only degrees to be conferred in course. This suggestion met with much approval from members of the graduate school.

Dr. W. H. Jordan, director of the New York State Experiment Station, spoke very earnestly of the need of more thorough scientific research along agricultural lines, and impressed his hearers with the great importance of maintaining the strictest integrity in making and recording agricultural investigations.

Dr. W. O. Thompson, president of Ohio State University and one of the founders of the graduate school, gave a brief account of the origin of the school, and expressed his strong belief in its value as an aid to broadening and strengthening our system of agricultural education. He predicted that it would have a career of increasing success and usefulness. Dr. Brown Ayres, president of the University of Tennessee, spoke from the standpoint of one interested in general educational advancement, and emphasized the importance of the movement for the development of a thorough system of agricultural education.

A conference on extension work in agriculture was held July 21, at which great interest in this feature was developed. Resolutions favoring the aid of the Office of Experiment Stations in this direction were adopted.

A meeting of dairy instructors and investigators July 17–19 resulted in the formation of a national organization, as mentioned above. At this meeting a regular programme was presented, covering the whole range of dairy teaching and experimentation. The papers and discussion brought out the urgent need of scientific investigation to solve many practical problems in dairying and in the feeding of dairy cattle. Emphasis was placed on the demand for more and better trained men in dairy work, and on raising the standard of dairy instruction. Prof. R. A. Pearson, of Cornell University, was elected president of the association; C. B. Lane, of the United States Department of Agriculture, secretary-treasurer, and committees were appointed upon various topics.

Informal meetings were held several evenings at which questions relating to various phases of agricultural education were discussed. Among these were the methods of teaching agronomy, the organization of secondary and elementary courses in agriculture, and the science of agriculture as a basis for the organization of a system of agricultural education. These meetings were to some extent a continuation of the daily sessions and seminars. This atmosphere of discussion of matters of fundamental importance in agricultural education and research was probably one of the most beneficial features of the school.

On Saturday, July 14, about 70 members of the school visited the estate of the Funk Brothers, near Bloomington, Ill., comprising about 25,000 acres, where crop and animal production on a large scale was seen under the best conditions, as well as considerable experimental work in breeding oats and corn.

When news came of the death of Hon. H. C. Adams, the school adopted resolutions expressing their appreciation of the services rendered to the cause of agricultural education and research by Mr. Adams, in securing the passage of the "act which will forever bear his name and associate him in the minds of our people with Senator Morrill, of Vermont, and Representative Hatch, of Missouri, through whose wise statesmanship our agricultural colleges and experiment stations have been established and maintained."

The interest in the work of the school was well sustained throughout the session. There was considerable going and coming of students, a few even registering during the last week. Even those who stayed only a few days seemed to feel that they had received inspiration and information which made their coming to the school worth while. The students were unanimous in their expressions of the benefits and the broadening influence of the school, and in the general hope that another session might be held two years hence.

THE AGRICULTURAL COLLEGES.

The fiftieth anniversary of the passage of the act incorporating the Maryland Agricultural College was celebrated with appropriate exercises March 6, 1906. Addresses were given by President R. W. Silvester; President Ira Remsen, of Johns Hopkins University; Dean L. H. Bailey, of Cornell University College of Agriculture; Secretary of Agriculture James Wilson; and Prof. F. A. Soper, an alumnus of the college.

The act of incorporation of the Maryland Agricultural College was dated March 6, 1856, the corner stone of the main college building was laid August 24, 1858, and the institution was opened for students in September, 1859. The Michigan Agricultural College was provided for in the State constitution of 1850, created by act of the State legislature in 1855, and opened to students May 13, 1857. "To Michigan, therefore, belongs the honor of having been the first of the States to put in actual operation an educational institution for the direct promotion of technical training in agriculture."[a] The Michigan Agricultural College will celebrate the fiftieth anniversary of its opening by appropriate exercises May 28–31, 1907.

In 1906 agricultural colleges were in operation in all the States and Territories, except Alaska, Hawaii, and Porto Rico. In the Southern States separate colleges are maintained for negroes, and in this way the total number of agricultural colleges in the United States is 63. The number of white students in four-year agricultural courses in 1906 was 2,911, and in shorter courses, 4,764; of negro students, 1,798 were enrolled in agricultural courses.

APPROPRIATIONS.

Several large State appropriations for buildings and current expenses of the colleges were granted during the year. The University of Georgia was given $100,000 for the purpose of erecting and equipping buildings for the agricultural college, and through the efforts of the alumni of the institution a farm of about 800 acres, valued at about $100,000, has been acquired adjacent to the campus.

In Ohio the legislature appropriated a total of $135,000 for the college of agriculture—$45,000 for land, $80,000 for buildings, and $10,000 for the purchase of live stock. The $80,000 for buildings will be used for a judging pavilion, a cattle barn, and a horse barn, all as separate structures.

In Iowa the legislature extended for a period of five years the one-fifth mill tax levied in favor of the college of agriculture. This will provide about $125,000 a year for buildings. About $175,000 remains from the present millage tax, which will be applied on the

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[a] U. S. Dept. Agr., Yearbook 1894, p. 91.

new agricultural building, to cost $275,000. The building will be completed from the new millage tax. An appropriation of $5,000 annually was made for good roads instruction and investigation, $3,500 annually for an engineering experiment station, and $2,400 for library. The legislature also appropriated $11,000 for the purchase of 135 acres of additional land, 80 acres of which will be used for grazing purposes and experimental work in animal husbandry, and 55 acres for orchard instruction and experimental work in forestry. An appropriation of $5,000 was made for buildings on the dairy farm and an equal amount for the poultry plant; and $15,000 was provided for agricultural extension work, for the conduct of which an extension department has been established.

The State legislature of Virginia appropriated $86,000 for the college of agriculture and the experiment station for the biennial period. Of this amount $60,000 is to complete and equip the agricultural building, $5,000 a year for the experiment station, $6,000 a year for the crop pest commission, and $2,000 a year for furthering the cattle tick work.

The Massachusetts Agricultural College, in addition to its regular permanent appropriations, received $75,300, apportioned as follows: For erecting, heating, and equipping a building for the botanical department, $45,000; for a new barn and a new wagon house, $21,300; for a dairy building to be used simply for the handling of the farm product, $3,000; for a new piggery, $1,000; for repairs to buildings, $3,000; and for the further maintenance of the college, $2,000. The new buildings provided for, except that for the botanical department, are to replace those lost by fire. For the new barn an unexpended balance of insurance money amounting to $12,000 is also available. The permanent appropriation of the State to the college now amounts to about $57,000 annually.

The New Jersey College of Agriculture has an appropriation of $24,000 for the establishment of short courses in agriculture, and $6,500 for the maintenance of the same. The college also received $27,000 due on scholarships for 1902–1905, and $12,000 on scholarships for the present year.

The New Hampshire College of Agriculture and the Mechanic Arts has received a number of gifts, among which were $20,000 given by Andrew Carnegie, and $10,000 by the Hamilton Smith estate, of Durham, for a new library. The Durham Library Association will turn over to the college library its collection of books, valued at $10,000, and also the income from its invested funds of $11,000 for the purchase of books. In exchange for this the college will extend the privileges of the consolidated library to all citizens of the town. The town of Durham will make a small appropriation annually toward the support of the library. Mrs. Hamilton Smith, of Durham, has

recently given the sum of $10,000 for a new women's hall, which is much needed.

The Florida State Normal and Industrial School has received from Andrew Carnegie $10,000 for a new library.

To the University of California has been bequeathed the estate of the late M. Theodore Kearney, near Fresno, comprising about 5,000 acres of land, valued at about $1,000,000 and yielding an annual income of some $50,000, preferably for the endowment of agricultural education and research.

BUILDINGS.

While there are many important college buildings for agriculture in process of construction, few of these buildings have been completed during the past year. The University of Arkansas, however, has completed six buildings, including two dormitories, a $15,000 chemistry building, a $12,000 agricultural building, a $6,000 dairy building, and a hospital. The new administrative building of the University of California has been completed at a cost of about $267,000, with an additional expenditure of $26,000 for equipment. A new entomological laboratory has been dedicated for the use of both college and station. It occupies a new building consisting of three stories and a basement. The central building of the Iowa State College of Agriculture and Mechanic Arts has also been completed, the total expense for building and furniture amounting to $410,000. The University of Florida was removed during the summer of 1906 from Lake City to its new location at Gainesville. At the latter place it has now only three buildings, but is planning an elaborate and costly modern plant. The agricultural building at the University of Illinois is undergoing an overhauling as the result of the removal of the household science department to the new women's building and the erection of a farm mechanics building on the back part of the campus. These changes have been necessitated by the rapid growth of the college of agriculture, which at the time of the erection of the agricultural building consisted of 7 instructors and 19 students. Now, six years later, there are 44 employees in the college and station and 430 students. At the Michigan Agricultural College the campus has been extended by removing all of the older barns back 200 or 300 yards, thus providing room for a new agricultural building which it is proposed to erect in the near future.

Among the new buildings which are in process of erection are the $250,000 college of agriculture buildings at Cornell University, a new $45,000 botanical building at the Massachusetts Agricultural College, a new main building at the college of agriculture of the University of Minnesota, and a new agricultural-horticultural building at the Oklahoma Agricultural and Mechanical College.

WORK OF THE COLLEGES.

Much progress has been made during the year in the organization of the agricultural courses of the land-grant colleges along broader lines, in the specialization of courses, and in organizing extension work. At the Maryland Agricultural College the general agricultural course has been subdivided, and separate courses are now offered in agronomy, animal industry, horticulture, and chemistry. Likewise at the Montana State College of Agriculture and Mechanic Arts the general agricultural course has been expanded into separate courses in agronomy, animal husbandry, dairying, and horticulture; and a three-year elementary course in agriculture continuing for six months of the year has been offered in the newly created school of agriculture. A school of agriculture has also been established in connection with the University of Idaho, providing a four-year course preparatory to the regular college work. The university also announces a four-year course in domestic economy. A four-year course in household economics is now offered by Purdue University, the course leading to the degree of bachelor of science. Farm mechanics has been added to the curriculum of the school of agriculture of Purdue University and to that of the Michigan Agricultural College. Cornell University College of Agriculture offers two new short courses for women, one in horticulture and the other in home economics. Simmons College, of Boston, has recently taken over the property and management of the Boston Cooking School and established a regular four-year course in domestic science and a one-year course for those who do not wish to devote more time to this study. The two-year horticultural course formerly offered by the Massachusetts Agricultural College for women students of Simmons College has been discontinued.

A four-year course in forestry, leading to the degree of bachelor of science, is now offered by the Oregon State Agricultural College. A school of forestry has also been started in connection with Colorado College, at Colorado Springs, which has recently acquired by gift 15,000 acres of forest land. An endowment of $150,000 is being raised for a chair of practical forestry and lumbering at the Yale Forest School. This chair has already been established and the work is now being organized.

A department of agricultural extension has been organized at the Iowa State College of Agriculture and Mechanic Arts, with P. G. Holden as superintendent; M. L. Mosher, in charge of farm crops; P. K. Bliss, in charge of animal husbandry; A. H. Snyder, in charge of soils; J. C. Guthrie, in charge of dairying; J. W. Jones, in charge of horticulture; Miss Mary F. Rausch, in charge of household economics, and G. E. Stayner, secretary. One of the features of extension work in Iowa during the past year was a short course in corn and live stock

judging and domestic science, held under the management of the Young Men's Christian Association of Mount Pleasant, Iowa, December 17–22.

Departments of education have been established during the year at the Louisiana State University and Agricultural and Mechanical College, and at the University of Maine. The Massachusetts Agricultural College also has an appropriation of $5,000 for normal work and is planning to promote agricultural instruction in the elementary grades. Departments of education, in which attention is given to training teachers of agriculture are now maintained in connection with the University of Illinois, University of Missouri, and the Washington State College. There are also departments of education in connection with the State universities in California, Georgia, Minnesota, Nebraska, Tennessee, and Wisconsin. Normal courses in which agriculture is a feature have been definitely outlined and announced in the catalogues of the University of Arkansas, Iowa State College of Agriculture and Mechanic Arts, Kansas Agricultural College, and the Mississippi Agricultural and Mechanical College. Two-year normal courses are offered by the Colorado and Connecticut agricultural colleges, Cornell University, the North Carolina College of Agriculture and Mechanic Arts, North Dakota Agricultural College, Oklahoma Agricultural and Mechanical College, and a three-year normal course is provided by the South Dakota Agricultural College. Summer schools for teachers have been maintained during the year in connection with the universities or agricultural colleges in California, Connecticut, Georgia, Illinois, Kansas, Kentucky, Maine, Mississippi, New York, Ohio, Utah, Washington, and Wisconsin. A correspondence course for teachers is offered by the North Dakota Agricultural College.

Among the eminent educators who have been honored by pensions from the Carnegie Foundation for the Advancement of Teaching during the year are Prof. J. S. Newman, recently connected with Clemson Agricultural College, of North Carolina; and Dr. J. M. McBryde, president of the Virginia Polytechnic Institute. It is understood that the latter will retire from active college work at the close of the college year 1907.

J. Ogden Armour has offered to the president of the International Live Stock Exposition the sum of $5,000 to be distributed annually at the exposition in twenty agricultural scholarships to be competed for by the State agricultural colleges at the exposition. In a letter to the president of the exposition he states that these scholarships are given in recognition of the work done by the agricultural colleges "in advancing the cause of agricultural education in this country through the character and extent of their exhibits of live stock and field products at the international show."

The competition is to be based upon the animal and grain exhibits from the several colleges and such other forms of agricultural student competition as may be recognized or established by the exposition, The details are to be determined by the management, and the scholarships are to be known as the J. Ogden Armour scholarships.

A meeting of representatives of many of the agricultural colleges and the managers of the International Live Stock Exposition has since been held, and plans for the distribution of these scholarships have been decided upon. One scholarship will be given to each college leading at the exposition in judging horses, cattle, swine, sheep, and corn; one to the college making the best exhibit of feedstuffs; and one to the college making the highest average. The remaining thirteen will be apportioned according to the winnings of the colleges at the show, except that no college may receive more than 40 per cent of the total number. The awarding of the scholarships to students will be done by the respective colleges.

THE SECONDARY SCHOOLS.

The need of secondary courses in agriculture is coming to be more definitely recognized. As noted above, secondary courses have been organized this year in the Montana and Idaho colleges. An agricultural course has been conducted during the year in the public high school at St. Louis, Mich., and the class in agriculture is the largest class in the school. It is reported by the State superintendents of public instruction that agriculture is taught in 200 high schools in Missouri, 30 in Ohio, and one or more in Alabama, New Hampshire, Pennsylvania, New York, Iowa, Kansas, Nebraska, Louisiana, Indiana, Maine, Idaho, Montana, North Dakota, Oklahoma, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, and Wisconsin.

In New Hampshire, beginning with 1906, high schools and academies may be approved by the State superintendent of education if they are prepared to teach agriculture. Recent legislation in Virginia provides for the establishment of public high schools under the authority of the State superintendent of education. Arrangements are being made to open about 150 such schools, and it is intended to make instruction in agriculture a feature of the course in such of these schools as are located in the country.

A new high school has been opened at Petersham, Mass., with a course in agriculture. Edwin H. Scott, a graduate of the Massachusetts Agricultural College, is instructor in that department. Much interest has been exhibited in the provision of this new course, which was equipped in advance of any other department in the school.

At the California Polytechnic School a new two-story domestic science building, 42 by 103 feet, is just being completed. It contains on the first floor an office and reception room, two sewing rooms, with

adjoining cloakroom, closets, and fitting room, a lecture room and a class room for classes in botany, with adjoining office and herbarium. On the second floor are the kitchen, laboratory, pantry, butler's pantry, lockers, dining room, office, two class rooms (one for bookkeeping), and rest room.

At the Hampton Normal and Agricultural Institute a special three-year course has been inaugurated for those who wish to take agriculture as their main work, and each boy who undertakes the course will put in seven hours of every school day in actual field work under the direction of an instructor, and will also receive two hours of theoretical agriculture and occasionally some night work. The Shellbanks Farm, which has hitherto been conducted almost entirely on a commercial basis, has recently been turned over to the agricultural department, under the direction of Prof. E. C. Bishop, and will henceforth be utilized largely for the instruction of agricultural students.

Marinette County, Wis., is erecting a building for a new agricultural high school, patterned after those already in operation in Dunn and Marathon counties. A bill appropriating $80,000 to St. Lawrence University for the establishment of an agricultural course and $12,000 for maintenance has been passed by the New York legislature and signed by the governor. New agricultural high schools have been established at Crookston, Minn., and Calvert, Md.

CECIL COUNTY AGRICULTURAL SCHOOL, CALVERT, MD.

(Pl. IX.)

Upon request of the patrons in the northern part of Cecil County, Md., for the establishment of a high school at Calvert, the Cecil County school board decided, in the summer of 1906, to establish such a school and give the course of study an agricultural trend. The school board applied to R. W. Silvester, of the Maryland Agricultural College, and to the United States Department of Agriculture for aid in organizing the school. Mr. H. O. Sampson, a graduate of the Iowa State College of Agriculture and Mechanic Arts, who had had experience in teaching elementary agriculture in a high school in Pennsylvania, was furloughed from this Office to take charge of the school as principal and teacher of agriculture. The school was opened November 5, 1906, in a small two-room school building rented from the Society of Friends, and having an available area of about 9 acres of land adjacent to it. Thirty-eight pupils were enrolled on the first day, and the number has since grown to 51. A small recitation room has been converted into a laboratory and meagerly equipped with simple apparatus, mostly the handiwork of the principal and pupils. Here experiments in which the pupils take part are performed daily. The agricultural work is popular among the pupils and is also

FIG. 1.—LABORATORY OF CECIL COUNTY (MD.) AGRICULTURAL SCHOOL.

FIG. 2.—LECTURE ON THE HORSE, CECIL COUNTY SCHOOL.

arousing much interest among the farmers of the county. Some of the county papers are devoting part of a column each week to the Calvert school. The principal visits other schools in the vicinity for the purpose of getting their teachers and pupils interested in agricultural subjects.

The regular work of the school begins with the seventh year, but at the present time some sixth-grade work is being done in order to allow the other schools to bring their work up to a point where it will articulate with the Calvert course. Following is the course of study as prepared by the principal of the school and the expert in agricultural education of this Office and revised by the Cecil County school board:

Course of study for Cecil County Agricultural School, Calvert, Md.

Grade.	Language.	Mathematics.	Science.	History.	General exercises.
First year	Spelling; Grammar; Composition.	Arithmetic, Algebra.	Agriculture, plants and soils; Physical geography.	United States and Maryland history; Civics.	Free-hand drawing; Writing; Agricultural practice.
Second year.	Grammar; Literature; Composition.	Farm and business arithmetic; Algebra.	Agriculture, farm crops; Botany.	English history; Civics.	Mechanical drawing; Agricultural practice.
Third year.	Literature; Rhetoric; Composition; Latin.	Farm bookkeeping; Plane and solid geometry.	Agriculture, domestic animals; Physics.	Ancient history.	Mechanical drawing; Farm mechanics; Agricultural practice.
Fourth year.	Literature; Rhetoric; Composition; Latin;	Geometry; Trigonometry and farm surveying.	Agriculture, farm management; Chemistry, general and agricultural.	Medieval and modern history; Review of United States history.	Farm mechanics; Field surveying and mapping; Agricultural practice.

Agriculture.

I. *Class-room exercises.*

FIRST YEAR.

The structure and physiology of plants.—How plants feed, grow, and reproduce, and their relation to light, heat, moisture, air, and soil.

Soils.—Their nature, functions, origin, properties, classes; relation to temperature, air, and moisture, and their management, including tillage, drainage, the use of manures, and the effect of cropping.

SECOND YEAR.

Farm crops.—Study of the principal field, orchard, and garden crops of the region, with reference to culture, protection from insect pests and diseases, and methods of harvesting and marketing.

THIRD YEAR.

Domestic animals.—Classes, types, breeds, care, and management of horses, cattle, sheep, swine, and poultry. Score card and judging practice. Study of dairy animals—their feeding, care, and management. Milk—its composition, handling, and uses.

FOURTH YEAR.

Farm management.—Comparison of different systems of cropping and tillage; different types of farming—such as grain farming, stock farming, and dairy farming. Farm plans, including size and location of fields, location of buildings, fences, drains, and roads. Construction of buildings, water and sewage systems, and roads. Use, care, and management of farm machinery. Farm accounts, including feed, milk, crop, and breeding records.

II. *Practice work.*

FIRST YEAR.

Laboratory exercises.—Seed testing, experiments with plants and soils.

Field exercises.—Studies of plants and soils and farm operations. Plat work.

SECOND YEAR.

Laboratory exercises.—Selecting and scoring farm crops, study of injurious insects.

Field exercises.—Plat work, spraying and pruning, field excursions, and corn and grain judging.

THIRD YEAR.

Laboratory exercises.—Studies of milk, butter, and other dairy products.

Field exercises.—Plat work and stock judging.

FOURTH YEAR.

Laboratory exercises.—Chemistry of soils and plant and animal life.

Field exercises.—Plat work, stock judging, study of farm machinery, buildings, roads, drainage systems, etc.

DISTRICT INDUSTRIAL AND AGRICULTURAL SCHOOLS IN GEORGIA.

By legislative enactment in the summer of 1906, the general assembly of Georgia authorized the governor of that State to establish and cause to be maintained in each of the eleven Congressional districts of that State an industrial and agricultural school, said schools to be branches of the State College of Agriculture and under the general supervision of the board of trustees of the University of Georgia, of which the college of agriculture is a department. Each school will receive for maintenance an equal share approximately of the inspection fees collected by the State department of agriculture not otherwise appropriated, amounting as now estimated to about $6,000 a year, but the different localities in which the schools are located must furnish not less than 200 acres of land and the necessary equipment in the way of buildings, live stock, machinery, farm implements, etc.

Soon after the enactment of this law the governor of Georgia applied to the Secretary of Agriculture for the assistance of experts from this Department to aid in selecting suitable farms for the schools and preparing a course of study for them. The Secretary of Agriculture detailed W. G. Smith of the Bureau of Soils and the expert in agricultural education of the Office of Experiment Stations for this

service. Mr. Smith has been in Georgia on this detail most of the time since October 1. From his preliminary report of December 24, 1906, to the Chief of the Bureau of Soils, who transmitted the same to the Director of this Office, the following statements concerning the location of the schools and the donations for their equipment are taken.

The movement seems to have met with much popular favor on all sides, resulting in gifts to the State from private sources of about 3,044 acres of land, valued at about $137,500, and cash donations amounting to $470,000, a total of $607,500. Including the electric light, water, and telephone privileges, and sewerage work, the aggregate value of gifts so far made the State from private sources will amount to over $800,000. The cash donations are intended to be used only for the erection of buildings and other fixed improvements on the various school grounds.

Each school has a local board of trustees appointed by the governor and consisting of one member from each county in the district. Each board is to cooperate with the governor and the faculty of the State College of Agriculture at Athens in deciding upon courses of study and lines of farm work to be carried on.

The board of trustees of the University of Georgia, which has general supervision of the schools, has decided that the schools shall be coeducational; that the course of study shall extend over four years, including one year of common or elementary school work and preparing graduates for entrance at the State College of Agriculture; that the minimum age for entrance into the schools be 14 years for boys and 13 years for girls; that the scholastic year extend over forty weeks; that the programme be so arranged that each student shall devote at least three hours of each day to class-room work and three hours to farm, home, shop, or laboratory work; that the girls be provided with suitable training in cooking, sewing, home economics and kindred subjects, and that short courses for adult farmers be provided in so far as the same may not conflict with the other work of the schools.

In order to keep the work moving smoothly on the school farm, it is proposed to arrange the classes into sections, so that while two sections are engaged in class-room work, the other two will be employed in home, laboratory, plat, and field work. The sections will probably have half-day shifts, which means, for example, that a given student will have all his studies in the forenoon and all his shop and field work in the afternoon, while another student will have the reverse order.

The only expense to the students will be the cost of board, which it is estimated will come to about $10 a month. The proposed course of study provides for manual labor on the farm, for which the student is to receive pay that may amount to $5 or more a month, thus making

the net cost to the student for the school year (eight months) not more than $45 or $50. It has also been decided that about one-fourth of the students shall be required to remain on the farm during

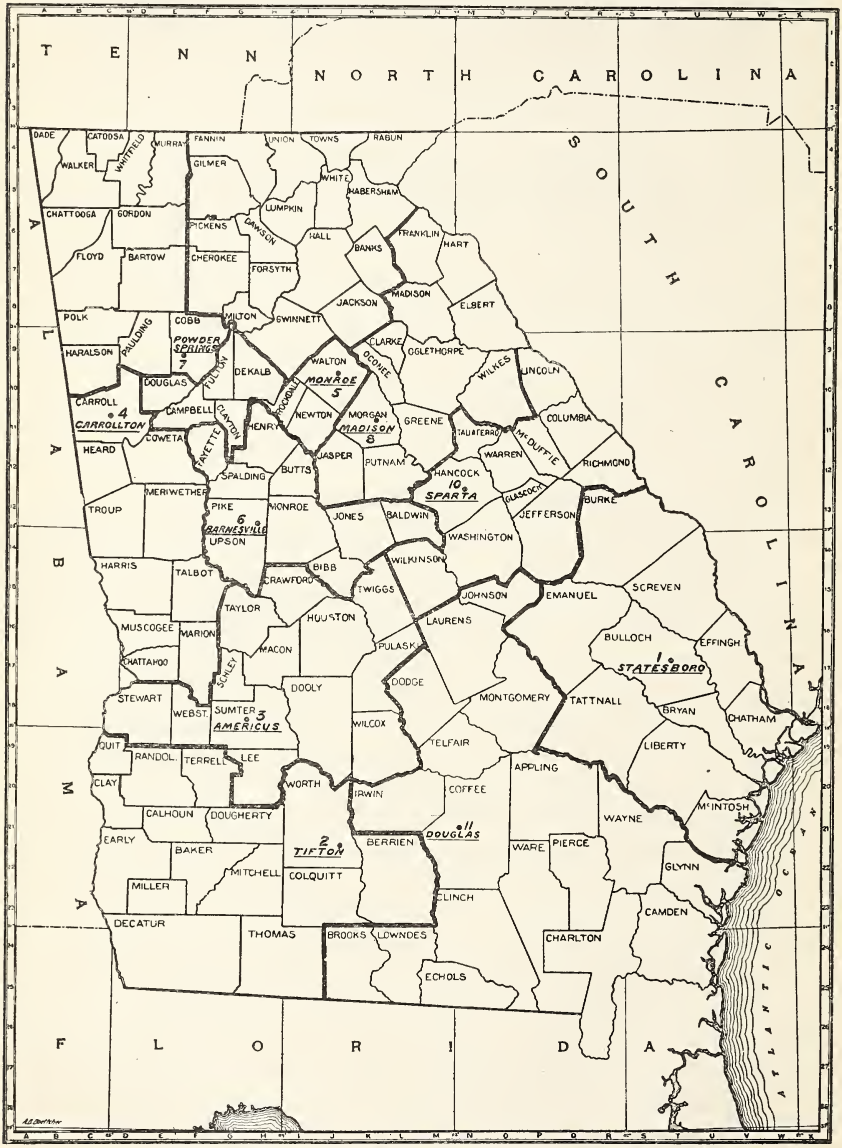
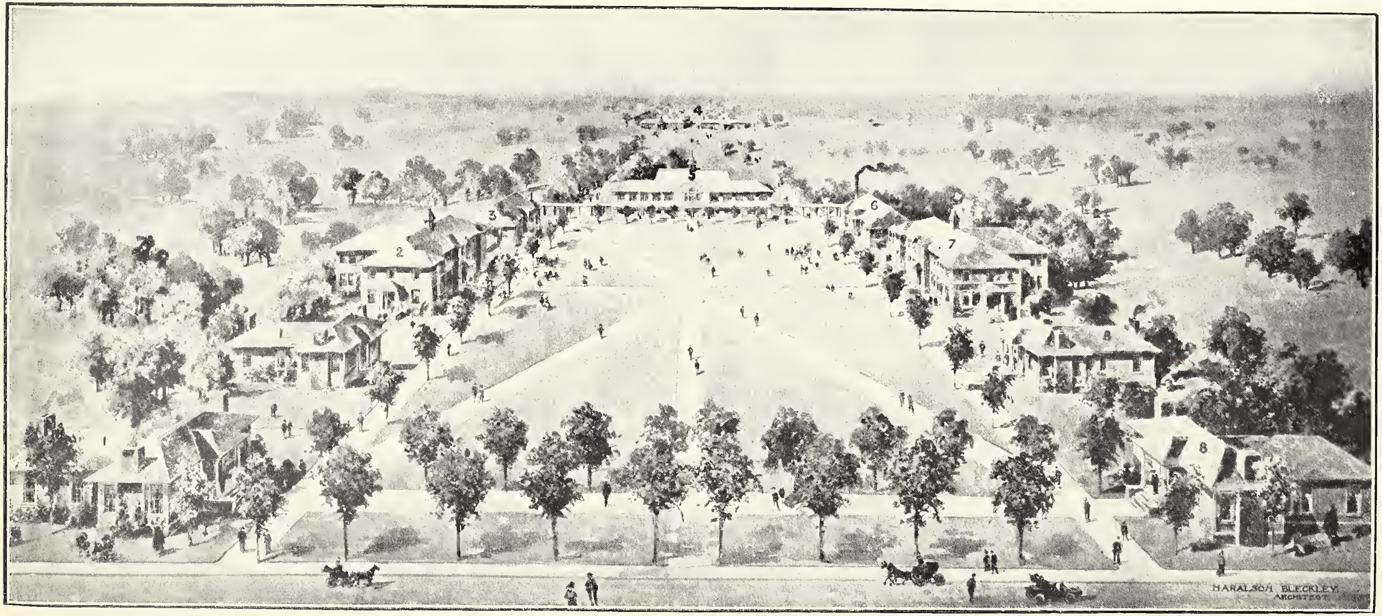


FIG. 1.—Map showing industrial and agricultural school districts of Georgia.

the summer vacation and that they may be paid for this work, thus reducing somewhat their school expenses.

Five or more teachers are contemplated for each fully organized school. These will include the principal, who is to be versed in prac-



PROPOSED PLAN OF INDUSTRIAL AND AGRICULTURAL DISTRICT SCHOOLS OF GEORGIA.

1. Cottages.
2. Girls' dormitory.
3. Domestic science and dining room.
4. Barns, poultry, greenhouses, etc.
5. Main building.
6. Power house and shops.
7. Boys' dormitory.
8. Cottages.

tical farming, as well as in the sciences underlying agricultural practice, a teacher of science, a teacher of domestic science and other special work for girls, a teacher of shop work and mathematics, and a teacher of English, history, and languages.

Plans and specifications for the principal school buildings have been prepared by a competent architect. Nine separate buildings are contemplated, to be arranged on three sides of a quadrangle as shown in Plate X, with barns and other farm buildings in the background.

The buildings for each school will cost $70,000 or more. The main academic building, built of brick, will cost about $15,000, while the boys' and girls' dormitories, if built of brick, will each cost a like amount. These three buildings are regarded as the first that should be erected. Some of the districts contributed so liberally that nearly the whole set of buildings can be erected at once, but many will have to rely on future State aid or further private gifts to enable the completion of the full complement of buildings.

The following statement gives the main facts as to locations (see also fig. 1), gifts of land, and cash donations, as well as something of the soil conditions for each Congressional district:

FIRST DISTRICT.

School to be located adjacent to Statesboro, and not far from railroad. Gifts of about 300 acres of land, valued at about $50 an acre; cash, $60,000; electric light, water, and telephone free for ten years.

The farm lies well within the limits of the "wire-grass belt" of the Coastal Plain. The three principal grades of land occurring in this belt are found on the school farm, namely: (1) The deep sands, (2) the gently rolling upland locally known as "pebble land," and (3) the low, flat, swampy lands.

The "pebble land" is noted for productiveness. The low, flat, swampy lands often support a natural growth of pine and an underbrush of gallberry bushes and coarse grass. Much ditching will have to be done before general field crops can be grown, the soil evidently being "sour" as well as too wet.

Sea-island cotton, bringing 25 to 35 cents a pound, is the great money crop of this part of the State. The natural forest growth of the district consists mainly of the long-leaf pine, with an undergrowth of tufts of wire grass.

SECOND DISTRICT.

School to be located on a railroad, about 3 miles north of Tifton. Gifts include 327 acres of land, valued at about $30 an acre; cash, $60,000; electric light, water, and telephone free for ten years. Independent sewerage is to be installed free of cost to the State, which may represent an outlay on the part of the donors of something like $10,000.

This farm also lies within the wire-grass belt of the Coastal Plain region, and the soil conditions are much the same as those of the first district. It contains, however, but very little flat, poorly drained land.

Most of the tract is covered with a natural growth of long leaf pine, which will be a source of valuable timber to be used in the several school buildings.

THIRD DISTRICT.

School to be located near Americus. Gifts include 300 acres of land, valued at $50 an acre; cash, $40,000; electric light and water free for ten years.

This tract lies toward the upper edge of the "wire-grass belt" of the Coastal Plain. The soils comprise what is locally known as "gray land," "mulatto land," and "red land." This farm includes some of the most productive upland of the Coastal Plain region.

FOURTH DISTRICT.

School to be located near Carrollton. Gifts include 250 acres of land, valued at about $50 an acre; cash, $30,000; electric light, water, and telephone free for ten years.

While geographically the school is located near one side of the district, it is nearly in the center of the white school population. Most of the farms are small (100 to 200 acres in size), and owned and operated by prosperous white farmers, while the remainder of the district contains large farms operated by many negro tenants.

This school farm lies within the old metamorphic (Piedmont) region of Georgia, the soils being derived from the granites, gneisses, and hornblende schists. The soils are locally known as "gray land," "mulatto land," and "red land." The school farm includes hilly and gently rolling areas of the soils mentioned, and doubtless will represent very well the average soil and surface conditions of this Congressional district.

FIFTH DISTRICT.

School to be located on a railroad, 3 miles north of Monroe. Gift of 250 acres of land, valued at about $30 an acre, and almost all cleared and ready for cultivation; cash donation, $31,000; electric light, water, and telephone service free for ten years. Grading of the grounds is to be done with county convict labor free of charge to the school.

The district as a whole includes many small farms, with white owners and operators. Some important cities are included in this district, among them Atlanta. The farm has the same geological (Piedmont) and soil conditions as that in the fourth district.

SIXTH DISTRICT.

School to be located near Barnesville, with good railroad facilities. Gift of 250 acres of land, mostly all cleared and ready for cultivation. The land is valued at about $50 an acre. Cash donation, $51,000. Electric light, water, and telephone free for ten years; also sewerage to be installed.

The district includes many small farms owned and operated by prosperous white farmers. The geological and soil conditions noted for the fourth district apply here also.

SEVENTH DISTRICT.

School to be located 3 miles north of Powder Springs. Gift of 240 acres of good land, valued at about $35 an acre, nearly all of which is cleared and ready for cultivation. The donors have agreed to put up free to the State the main building and the boys' dormitory, which, it is estimated, will cost them about $25,000.

The farm lies in the same geological province (Piedmont) and has the same soil conditions as the fourth district. These conditions apply, however, only to about the southern one-third or one-half of the seventh district.

EIGHTH DISTRICT.

School to be located near Madison and near railroad. Gifts include 257 acres of good land, valued at about $90 an acre; cash, $40,000; electric light and water free for ten years, and telephone service free for three years. The district includes many small

farms owned and operated by prosperous white farmers. The geological (Piedmont) and soil conditions indicated for the fourth district apply here also.

NINTH DISTRICT.

School to be located near Clarksville and about 3 miles from railroad.

The same geological province (Piedmont) and the same conditions of soil as found in the fourth district occur in the ninth district, but the interests here differ considerably from those that surround the farms of the other districts.

In the ninth district cotton is not so much in the ascendancy, while orchard fruits, poultry, and live stock are more important, the rather frequent hilly and rugged features of north Georgia being peculiarly well adapted to produce apples and peaches, the developments along these lines having been quite marked during the last few years.

TENTH DISTRICT.

School to be located on railroad, 3 miles east of Sparta, at a station called Granite Hill. Gift of 270 acres of land, valued at about $30 an acre. Land nearly all cleared and ready for plow. Cash donation, $48,000.

The district includes many small farms owned and operated by prosperous white farmers. There are a few large holdings. The geological province (Coastal Plain) and the soil conditions of the third district are in a large measure found here. The farm, however, lies near the line between the region of Coastal Plain sediments and that of the weathered granite rocks of the Piedmont.

ELEVENTH DISTRICT.

School to be located near Douglas, on line of railroad. Gifts include 300 acres of good land, valued at about $50 an acre; cash, $55,000; electric lights and water free for ten years; sewerage to be installed free.

The same geological province (Coastal Plain) and the same soil (wire-grass belt) conditions as found in the first district obtain here.

This school is located in a section which at one time had extensive lumber and turpentine interests, but where now there is progressing a considerable development of small farms operated by whites.

The donations made by the citizens of the different Congressional districts are summarized in the following table:

Donations for Georgia agricultural schools.

Congressional district.	Acres of land.	Value of land.	Cash donation.	Years' electric light free.	Years' telephone free.	Years' water free.	Sewerage to be installed.
First	300	$15,000	$60,000	10	10	10	
Second	327	15,000	60,000	10	10	10	Sewerage.
Third	350	15,000	40,000	10	10	10	
Fourth	250	13,000	30,000	10	10	10	
Fifth	250	8,000	31,000	10	10	10	
Sixth	250	13,000	51,000	10	10	10	Do.
Seventh	240	8,400	25,000				
Eighth	257	22,000	40,000	10	3	10	
Ninth	300	5,000	30,000				
Tenth	270	8,100	48,000				
Eleventh	300	15,000	55,000	10		10	Do.
Total	3,044	137,500	470,000				

SUMMARY.

Land values	$137,500
Cash donations	470,000
Approximate value of electric light, water, and sewerage, gift	200,000
Total gift to State	807,500

COURSE OF STUDY FOR GEORGIA SCHOOLS.

Upon invitation of Governor J. M. Terrell, the expert in agricultural education of the Office of Experiment Stations, and Joseph S. Stewart, professor of secondary education in the University of Georgia, met at the governor's office and, after conference with the governor and others, prepared the following tentative course of study for boys, which has since been submitted to the board of trustees of the University of Georgia as the basis of the courses to be pursued in the different schools. A similar four-year course for girls will be arranged in home economics, including the study of food, cooking, dining service, laundering, dairying, sewing, dressmaking, millinery, home ornamentation, and household science. These are to be studied and practiced in three-hour practicum periods (mentioned below in the course of study for boys) under the direction of a domestic science teacher. The suggestive schedule of daily recitations (Pl. XI) shows the proposed arrangement of student sections for class-room and practice work.

Tentative Course of Study.

FIRST YEAR.

	Hours per week.
English grammar and American authors	5 periods of 40 minutes.
Mathematics: Arithmetic	5 periods of 40 minutes.
United States history	3 periods of 40 minutes.
Penmanship and spelling	2 periods of 40 minutes.
Geography	4 periods of 40 minutes.
Total	19 periods or 12⅔ hours.
Class agriculture	3 periods or 2 hours.
Practice work	18 periods or 18 hours.
Total	21 periods or 20 hours.

SECOND YEAR.

English grammar, composition, selected literature	5 periods of 40 minutes.
Mathematics: Algebra	5 periods of 40 minutes.
Horticulture and botany	3 periods of 40 minutes.
History: Ancient	3 periods of 40 minutes.
Penmanship and spelling, or option	2 periods of 40 minutes.
Total	18 periods or 12 hours.
Class agriculture	3 periods or 2 hours.
Practice work	18 periods or 18 hours.
Total	21 periods or 20 hours.

THIRD YEAR.

English continued	5 periods of 40 minutes.
Mathematics: Algebra	3 periods of 40 minutes.
Rural law and farm accounts	2 periods of 40 minutes.

		6.30–9.00	9.00–9.40	9.40–10.20	10.20–11.00	11.00–11.40	11.40–12.20	12.20–1.30	1.30–2.10	2.10–2.50	2.50–3.30	3.30–4.10	4.10–4.50	4.50–7.00	7.00–9.00	9.30
FIRST YEAR	MON.	MORNING CHORES, BREAKFAST, HOUSEHOLD DUTIES, STUDY.	ENGLISH[A]	ARITHMETIC[C]	U.S. HISTORY[A]		AGRICULTURE[B]	DINNER HOUR	PRACTICUM {GIRLS AND BOYS} PLANT LABORATORY				VARYING WITH SEASON, WEATHER, LOCATION, ETC. SUBDIVISION MADE BY PRINCIPAL.	RECREATION EVENING CHORES, SUPPER, CHAPEL SERVICE.	STUDY HOURS.	LIGHTS OUT.
	TUES.		“	“		GEOGRAPHY[A]	PENMANSHIP, SPELLING[A]		FARM WORK (BOYS) HOME WORK (GIRLS)							
	WED.		“	“	U.S. HISTORY	“	AGRICULTURE[B]		PRACTICUM {GIRLS BOYS SEWING, BASKETRY. PLAT WORK.							
	THUR.		“	“		“	PENMANSHIP, SPELLING[A]		FARM WORK (BOYS) HOME WORK (GIRLS)							
	FRI.		“	“	U.S. HISTORY	“	AGRICULTURE[B]		PRACTICUM {GIRLS BOYS COOKING AND DRAWING FARM MECHANICS							
	SAT.								FARM WORK (BOYS) FLOWERS (GIRLS)							
SECOND YEAR	MON.	MORNING CHORES, BREAKFAST, WORK AS ASSIGNED.	FARM WORK (BOYS) HOME WORK (GIRLS)				COVERING ALL KINDS OF WORK OF FARM, HOME AND SHOP.		ENGLISH[A]	ALGEBRA[C]	ANCT. HISTORY[A]		PEN. SPELL.[A]			
	TUES.		PRACTICUM {GIRLS AND BOYS} PLANT AND SOIL LABORATORY						“	“		HORTICULTURE, BOTANY[B]	AGRICULTURE[B.P.]			
	WED.		FARM WORK (BOYS) HOME WORK (GIRLS)						“	“	ANCT. HISTORY		PEN. SPELL.			
	THUR.		PRACTICUM {GIRLS BOYS SEWING FRUIT, GARDEN, PLAT WORK.						“	“		HORT. AND BOTANY	AGRICULTURE			
	FRI.		FARM WORK (BOYS) FLOWERS, VEGETABLE GARDEN.						“	FARM ARITH.	ANCT. HISTORY	HORT. AND BOTANY.				
	SAT.		PRACTICUM {GIRLS BOYS COOKING FARM MECHANICS													
THIRD YEAR	MON.	MORNING CHORES, BREAKFAST, STUDY.	PHYSICS[B]	ENGLISH[A]		FOR LANG., SCI. OR OTHER OPTION	ALGEBRA[C]		FARM WORK (BOYS) HOME WORK (GIRLS)				COVERING ALL KINDS OF WORK OF FARM, HOME AND LABORATORIES.			
	TUES.		AGRICULTURE[B.P.]	“	ENGLISH HIST.[A]	“	“		PRACTICUM {GIRLS AND BOYS} PHYSICS LABORATORY							
	WED.		PHYSICS[B]	“		“	“		FARM WORK (BOYS) HOME WORK (GIRLS)							
	THUR.		AGRICULTURE[B.P.]	“	ENGLISH HIST.	“	RURAL LAW, FARM ACCTS.		PRACTICUM {GIRLS BOYS SEWING, HAT TRIMMING. PLAT, FIELD WORK, DAIRY.							
	FRI.		PHYSICS[B]	“		“	“		FARM WORK (BOYS) DAIRY (GIRLS)							
	SAT.								PRACTICUM {GIRLS BOYS COOKING, LAUNDERING. FARM MECHANICS							
FOURTH YEAR	MON.	MORNING CHORES, BREAKFAST, WORK AS ASSIGNED.	PRACTICUM {GIRLS AND BOYS} CHEMICAL LABORATORY				VARYING WITH SEASON, WEATHER, LOCATION, ETC. AS AUTHORITIES MAY DIRECT.		CHEMISTRY[B]			FOR LANG., SCI. OR OTHER OPTION.	GEOMETRY[C]	FACULTY P. PRINCIPAL AND DIRECTOR OF FARM PRACTICUMS AND WORK. ASSISTS IN INSTRUCTION IN AGRICULTURE. A. TEACHER OF ENGLISH, HISTORY, LANGUAGE. B. TEACHER OF SCIENCE. C. TEACHER OF MATHEMATICS, CARPENTRY, SHOPWORK. D. TEACHER OF DOMESTIC SCIENCE AND SPECIAL WORK FOR GIRLS.		
	TUES.		FARM WORK (BOYS) HOME WORK (GIRLS)						AGRICULTURE[B OR P]	ENGLISH[A]	CIVICS, FARM ECONOMICS[A.P.]	“	“			
	WED.		PRACTICUM {GIRLS BOYS HOUSEHOLD ECONOMICS, HYGIENE. FIELD EXERCISES						CHEMISTRY[B]	“		“	“			
	THUR.		FARM WORK (BOYS) HOME WORK (GIRLS)						AGRICULTURE[B OR P]	“	CIVICS, FARM ECONOMICS	“	“			
	FRI.		PRACTICUM {GIRLS BOYS HOME MANAGEMENT FARM MECHANICS						CHEMISTRY[B]	“		“	“			
	SAT.		FARM WORK (BOYS) BEES, POULTRY, ETC. (GIRLS)													

SUGGESTED SCHEDULE OF DAILY RECITATIONS FOR INDUSTRIAL AND AGRICULTURAL DISTRICT SCHOOLS OF GEORGIA.

	Hours per week.
Elementary and agricultural physics	3 periods of 40 minutes.
History: English	2 periods of 40 minutes.
Optional study (foreign language, commercial geography, or science)	5 periods of 40 minutes.
Total	20 periods or 13⅙ hours.
Class agriculture	2 periods or 1⅓ hours.
Practice work	18 periods or 18 hours.
Total	20 periods or 19⅓ hours.

FOURTH YEAR.

English continued	4 periods of 40 minutes.
Geometry	5 periods of 40 minutes.
Civics, farm economics	2 periods of 40 minutes.
Elementary and agricultural chemistry	3 periods of 40 minutes.
Optional study (foreign language, modern history, or science)	5 periods of 40 minutes.
Total	19 periods or 12⅔ hours.
Class agriculture	3 periods or 2 hours.
Practice work	18 periods or 18 hours.
Total	21 periods or 20 hours.

TOTALS FOR FOUR YEARS.

Class room other than agriculture.		Class room and practice work in agriculture in all its forms.	
Periods or hours a week:		Hours a week:	
First year	19 periods, 12⅔ hours.	First year	20 hours.
Second year	18 periods, 12 hours.	Second year	20 hours.
Third year	20 periods, 13⅙ hours.	Third year	19⅓ hours.
Fourth year	19 periods, 12⅔ hours.	Fourth year	20 hours.
Total	76 periods, 50½ hours.	Total	79⅓ hours.

Agriculture.

FIRST YEAR—FALL TERM.

Class room.—Three recitations a week.

The plant, its composition, structure, and physiology.

How plants feed, grow, and reproduce.

Plant laboratory.—One period a week, three hours.

Study a number of plants with reference to their composition and structure, their methods of reproduction, the uses of leaf, stem, root, flower, and fruit, and such processes as pollination, crossing, and hybridizing.

Plat work.—One period a week, three hours.

Each pupil will have a small garden in which the vegetables of the region can be grown. Care must be taken that all work in this garden be done in season and that such a rotation of crops be followed as will best utilize the space at all times. The pupil will be held responsible for the care of the garden, will be taught the best methods of preparing the ground and planting, cultivating, harvesting, and marketing the crop, and will be required to keep an accurate account of all labor and expense, and profit or loss. He will enjoy his profits or bear his losses, as the case may be.

Farm mechanics.—One period a week, three hours.

Free-hand and mechanical drawing: Lines and geometrical figures, using as models the garden stakes, boxes, dishes, etc., used in plat work, also the apparatus and plants used in the plant laboratory. Draw plans for all bench work.

Bench work: Exercises to develop skill in handling tools; make all stakes, yard-sticks, boxes, etc., used in plat work and plant laboratory.

Farm work.—Three periods a week, nine hours.

Pupils will be detailed, under competent superintendence, to attend to all the various operations of the farm, changing the details from time to time so that each pupil may become familiar with all the operations of the farm.

Those detailed to feed and care for the live stock and do other farm chores, morning, noon, and night, will be excused for the time being from other farm work.

During each vacation one-fourth of the students, or such number as the principal may consider necessary, will be required to remain at the school to carry on the operations of the farm and shops without interruption, and for work required during this time the students may be given fair compensation.

FIRST YEAR—WINTER TERM.

Class room.—Three recitations a week.

The plant, reproduction: Study various methods of reproduction, e. g., by spores, bulbs, cuttings, grafts, and buds; germination and plant food in seeds of different kinds, bulbs, and tubers.

Plant laboratory.—One period a week, three hours.

Exercises in germinating seed, making hard and soft cuttings, grafting and budding. The practical work of budding would better be deferred until summer or early autumn. Start seed in boxes and hotbeds for spring planting out of doors. Explain the physical and chemical principles involved in germination and hotbed work.

Plat work.—One period a week, three hours.

Continue garden work with special reference to winter operations, such as the preparation of soil, destruction of weed seeds and rubbish; and making plans for spring work.

Farm mechanics.—One period a week, three hours.

Mechanical drawing: Standard exercises and making plans for bench work. Occasional practice in free-hand drawing.

Bench work: Continue work of fall term with exercises gradually becoming more complex, such as the making of joints, splices, dovetails, etc.

Students will be required to sharpen and care for all tools used by them

Farm work.—One period a week, nine hours.

(See Farm work under fall term.)

FIRST YEAR—SPRING TERM.

Class room.—Three recitations a week.

The plant, its environment: Study the influence of light, air, heat, and moisture upon plant growth.

Plant laboratory.—One period a week, three hours.

Continue plant work of preceding term and study United States Weather Bureau daily charts; trace movement of storms and learn to use the barometer, thermometer, and hygrometer and other weather instruments. Experiment with plants in pots and boxes to determine the effect of light, heat, and moisture upon their development.

Plat work.—One period a week, three hours.

Prepare ground and plant seed in season in individual gardens; continue all necessary operations of cultivating, weeding, harvesting, and marketing early vegetables. Plan to have a succession of vegetables throughout the season.

Farm mechanics.—One period a week, three hours.

Mechanical drawing and bench work as in winter term. Begin practical farm carpentry, such as the making of benches, ladders, gates, and barn doors.

Farm work.—Three periods a week, nine hours.

(See Farm work under fall term.)

SECOND YEAR—FALL TERM.

Class room.—Two recitations a week.

Soils: Nature, function, origin, and properties of the principal soil types of the region. Root systems of farm crops.

Laboratory.—One period a week, three hours.

Collect samples of the leading types of soil in the region and bring them to the laboratory for study. Learn to distinguish and name different soils according to the classification by the Bureau of Soils of the United States Department of Agriculture.

Study root system of the leading farm crops, noting their general characteristics and how these are modified by different soils.

Plat work.—One period a week, three hours.

A series of demonstration plats will be laid out and put in charge of second-year pupils to show the effects of cropping, rotations and use of commercial fertilizers, barnyard manure and green manures on the fertility and physical condition of the soils, as well as upon the quality of crops produced.

A part of the field work of this term will be devoted to the collection of seeds, cotton, forage crops, roots, and other material for study in plant laboratory.

Farm mechanics.—One period a week, three hours.

Drawing: Make plans of buildings and other structures needed in the school, home, and farm.

Farm carpentry: Make models of farm buildings, and where practicable engage in the construction of real buildings.

Farm work.—Three periods a week, nine hours.

(As before.)

SECOND YEAR—WINTER TERM.

Class room.—Two recitations a week.

Soils, classification, temperature, aeration, moisture, and management. Principles governing tillage, drainage, terracing, uses of fertilizers and cropping.

Laboratory.—One period a week, three hours.

Pupils will conduct experiments with soils to illustrate their physical properties, such as porosity, capillarity, and effect of puddling, mulching, etc., using simple apparatus which can be made in the laboratory.

Toward the close of the term exercises in seed testing will be taken up to prepare for spring planting.

Plat work.—One exercise a week, three hours.

Field study of different types of soil as affected by different methods of treatment; influence of frost on fall-plowed soil as compared with soil not plowed; experiments in the handling and care of barnyard manure; study of the influence of winter catch crops.

Farm mechanics.—One period a week, three hours.

Drawing: Plans of farm buildings and fixtures.

Farm carpentry: Make models of buildings and plans and construct cupboards, mangers, stanchions and other fixtures, poultry buildings and yards, brooder houses and other minor farm buildings.

Farm work.—Three periods a week, nine hours.

(As before.) Attend also to pruning and spraying orchards.

SECOND YEAR—SPRING TERM.

Class room.—Two recitations a week.

Farm crops: Study leading field, garden, and orchard crops of region, laying particular stress on those of greatest local importance. Take up such matters as preparation of soil, selection of seed as determined by germination and purity tests, planting, cultivating, protection from insects and other pests, harvesting, and marketing.

Laboratory.—One period a week, three hours.

The botany of farm crops and crop judging with score card. In horticultural regions this period will be devoted to work with fruits and vegetables.

Plat work.—One period a week, three hours.

Give necessary care to demonstration plats, planting crops on them and cultivating them. Study field, garden, and orchard crops on the school farm and on neighboring farms, and attend to spraying, and other orchard and garden work.

Farm mechanics.—One period a week, three hours.

Iron work: Learn to make from stock iron various articles used on the farm, such as tongs, cold chisels, punches, rings, chain links and hooks, clevises, brackets, harrow teeth, etc.; how to use and take care of files; how to construct a serviceable forge and otherwise equip a shop for farm blacksmithing.

Give special attention to welding iron and steel, and to tempering tools.

Farm work.—Three periods a week, nine hours.

The work of this term in horticultural regions should be devoted largely to gardening, orcharding, or forestry.

THIRD YEAR—FALL TERM.

Class room.—Two recitations a week.

Animals: Study the leading breeds of horses, cattle, sheep, swine, and poultry, and learn to distinguish the characteristics of different types, such as draft and trotting horses, roadsters and saddle horses, dairy and beef cattle, wool and mutton sheep.

Laboratory.—One period a week, three hours.

Agricultural physics: Experiments with soils, farm machinery, dairy apparatus, and other farm equipment to illustrate the laws of physics.

Plat and field work.—One period a week, three hours.

Carry to completion through one growing season the plat experiments begun in second year.

Study and judge with the score card breeds of horses, cattle, sheep, swine, and poultry.

Farm mechanics.—One period a week, three hours.

Plumbing and steam fitting: Exercises which will prepare pupils to lay and fit the necessary pipes and fixtures for water, sewage, and heating systems in home and farm buildings, dairy, and cane mill.

Farm work.—Three periods a week, nine hours.

Students of the third and fourth years may be given acre plats for individual cultivation, or small farms for supervision, the profits to be their own; the same, however, to be applied first to the payment of their school expenses.

THIRD YEAR—WINTER TERM.

Class room.—Two recitations a week.

Animals, their care and management: Study food requirements of different animals and the importance of pure water supply, exercise and shade, comfortable, clean, and well ventilated buildings and inclosures, giving attention also to the preparation and marketing of animal products.

Laboratory.—One exercise a week, three hours.

Agricultural physics as in previous term, giving special attention to farm and dairy equipment.

Field exercises.—One exercise a week, three hours.

Continue judging exercises and study breeds of domestic animals.

Farm mechanics.—One period a week, three hours.

Farm machinery: Practice in assembling and setting up machines of the farm, dairy, and cane mill, and in placing lines of shafting, sewing belts, etc.

Farm work.—Three periods a week, nine hours.

(As before.)

THIRD YEAR—SPRING TERM.

Class room.—Two recitations a week.

Dairying: Make a more detailed study of the dairy type of cow, her feed, care, and management, and take up the subject of milk; study its composition, handling with reference to the relation of cleanliness, straining, aerating, and cooling on the souring or tainting of milk; use of milk for consumption as milk and cream, for condensing, for cheese making and butter making.

Laboratory.—One period a week, three hours.

The laboratory work of this term should be devoted to the dairy. Learn to use the Babcock test and centrifugal separator, different types of churns and workers, and take up practical work in salting, coloring, working, and packing butter for marketing.

Field work.

Visit some of the best farms in the region for the purpose of studying buildings and other inclosures for farm animals and poultry, taking note of all provisions for light and ventilation, cleanliness of buildings and surroundings, convenience of arrangement and other factors entering into the construction of suitable and serviceable farm buildings.

Farm mechanics.—One period a week, three hours.

Design farm houses, barns, dairy buildings, cane mills, and other buildings, making provision for water, sewage, and heating systems. Carry out these plans whenever possible in the construction of buildings on the school farm. Practice in laying concrete floors, walks, etc.

Farm work.—Three periods a week, nine hours.

(As before.)

FOURTH YEAR—FALL TERM.

Class room.—Two recitations a week.

Rural engineering: Study farm plans with reference to the size and location of fields; continue the study of farm buildings and begin the study of the construction of roads and the ornamentation of home grounds by the planting of trees and shrubs.

Chemical laboratory.—One period a week, three hours.

Chemical manipulations with elements and compounds which are of most importance in agriculture.

Field exercises.—One period a week, three hours.

Practical exercises in surveying and laying out ornamental grounds and fields, locating buildings and roads, drains, terraces, water systems, and sewage system.

Farm mechanics.—One period a week, three hours.

Draw farm plans and locate on them the necessary buildings, roads, orchards, and ornamental plantations.

Farm work.—Three periods a week, nine hours.

(As before.)

FOURTH YEAR—WINTER TERM.

Class room.—Two recitations a week.

Rural economics: Study systems of farming, transportation and other factors relating to markets, and farm records, including feed and milk records, crop records, breeding records, and inventories.

Chemical laboratory.—One period a week, three hours.

Agricultural chemistry, with special attention to the chemistry of foods, feeding stuffs, fertilizers, and animal products.

Field exercises.—One period a week, three hours.

Continue work of preceding term and practice work of keeping farm records.

Farm mechanics.—One period a week, three hours.

Topographical drawing and use of plane table.

Construction of roads and walks, grading, use of different road materials.

Farm work.—Three periods a week, nine hours.

(As before.)

FOURTH YEAR—SPRING TERM.

Class room.—Two recitations a week.

Rural economics: History of agriculture and agriculture in its relation to other productive industries, and the literature of agriculture, including publications of State agricultural experiment stations and the United States Department of Agriculture, and statistical and consular reports.

Laboratory.—One period a week, three hours.

Study of harmful and beneficial birds and insects in laboratory and field.

Library reading.—One period a week, three hours.

While the study of agricultural literature is an important part of the whole course, it is thought wise to devote considerable time in the last term to systematic library reading in order that the graduates may be familiar with the sources of the best works on agriculture.

Farm mechanics.—One period a week, three hours.

Practical work in planning and constructing farm and home structures, and in planting trees and shrubs for ornamental purposes.

Farm work.—Three periods a week, nine hours.

(As before.)

Horticulture and Forestry.

SECOND YEAR—SPRING TERM.

Class room.—Two recitations a week.

Study of the principles of vegetable gardening, orcharding, and forestry. This study will include such matters as selection of varieties, planting, cultivating, protecting from insects and diseases by spraying and by other methods, propagation, nursery work, pruning, harvesting, storing, preparing for market, and marketing. Attention will also be given to the utilization of waste lands by making forest plantations, care of forests, including protection from fires, thinning forests, and cutting and replanting.

Laboratory.—One period a week, three hours.

(See Agriculture, second year, spring term.)

Farm work.—Three periods a week, nine hours.

(See Agriculture, second year, spring term.)

THE PRIMARY SCHOOLS.

There is a growing sentiment in favor of teaching the underlying principles of agriculture in the schools attended by 94 per cent of the children of our country. This fact is indicated by the recent declaration of numerous men high in the official and educational councils of this country, by the progress made in many localities in the introduction of nature study, school gardening, and elementary agriculture into the public schools, by the widespread discussion of this subject

in educational gatherings and in newspapers and magazines, and by the number of text-books, bulletins, and other helps for teachers published recently.

The laws of over thirty States now permit or require the teaching of agriculture in the public schools. Among the States which require the teaching of agriculture in all elementary schools are Alabama, Georgia, Louisiana, Maine, Maryland, Mississippi, North Carolina, South Carolina, South Dakota, and Wisconsin. Ohio reports that elementary agriculture is taught in approximately 500 township schools, and this subject is regularly taught in rural schools numbering about 4,500 in Wisconsin, 3,000 in Missouri, 300 in North Dakota, and a considerable number of schools in Alabama, Georgia, Illinois, Indiana, Indian Territory, Iowa, Louisiana, Maine, Nebraska, New Hampshire, New York, North Carolina, Pennsylvania, South Carolina, South Dakota, Virginia, and Washington.

Permissive or mandatory legislation concerning the teaching of agriculture in the public schools is commonly accompanied with provisions making agriculture one of the subjects on which teachers may or must be examined. In Nebraska, for example, candidates for first and second grade county certificates must pass an examination in the elements of agriculture. In Wisconsin, since 1901, teachers have been required to pass an examination in elementary agriculture in order to secure any grade of teachers' certificate. In New Hampshire teachers in secondary schools are required to have training in agriculture. In Virginia teachers securing first-grade certificates must pass an examination on either physical geography, elementary physics, or elementary agriculture. In Alabama, Georgia, Mississippi, Missouri, North Carolina, and South Dakota all teachers must pass examination on this subject. In New York the new syllabus for elementary schools contains nature study and agriculture and teachers in training classes are required to cover all subjects in the syllabus. In Ohio the Teachers' Reading Circle requires the study of one text-book on elementary agriculture each year.

The work of the agriculture colleges in providing normal training in elementary agriculture has been referred to (p. 254). The colleges in Ohio, Iowa, Illinois, New York, Mississippi, and Rhode Island also have so-called extension departments which are seeking to come into close touch with teachers as well as with country boys and girls, and thus promote the wider diffusion of agricultural education. These colleges are also using their influence to turn students in their regular courses to the career of teaching. The agricultural high schools, whether attached to the agricultural colleges or independent of them, are also training teachers. Some of the normal schools in Alabama, Georgia, Idaho, Illinois, Iowa, California, Louisiana, Maine, Massachusetts, Michigan, Missouri, Montana, Nebraska, North Dakota,

Oklahoma, Texas, Vermont, Virginia, Washington, West Virginia, and Wisconsin are giving regular instructions in nature study and elementary agriculture.

Not content to wait for the formulation of definite courses of instruction in agriculture for the rural schools and the training of teachers in this subject, there is in many places an effort to do something tangible to arouse the interest of farmers' boys in the study of agriculture. Through the agency of farmers' organizations cooperating with the State agricultural colleges and State and county departments of education, boys' agricultural clubs have been organized, largely in connection with the schools, in Georgia, Illinois, Indiana, Iowa, Kansas, Minnesota, Nebraska, North Dakota, Ohio, Texas, Wisconsin, and probably other States. The members of these clubs have regular institute meetings and lecture courses, go on excursions to educational institutions and large farms, conduct variety tests with corn, cotton, sugar beets, and other crops, and exhibit their products at school, county, and State fairs.

A remarkable change has taken place in the attitude of school officers and teachers regarding nature study and elementary agriculture as school subjects. A few years ago it was unusual to find any subject relating to agriculture in public schools in the programmes of the teachers' meetings. Now scarcely an educational meeting of importance is held anywhere in the United States without at least one paper on some phase of this subject, and in many cases whole sessions are devoted to the discussion of various topics relating to it, from nature study and school gardening to the more formal courses in agriculture. A few examples will serve to show how widespread is this interest.

At the sixty-seventh annual convention of the American Institute of Instruction at New Haven, Conn., in July, 1906, which is largely attended by school officers and teachers from different parts of New England, the teaching of elementary agriculture was largely discussed in the department of rural education, formal papers on this subject being presented by the superintendent of education of Vermont and the professor of agriculture of the Massachusetts Agriculture College.

New England has also been aroused to a serious and thorough discussion of this matter by the report of a Commission on Industrial and Technical Education presented to the legislature of Massachusetts in April, 1906. The chairman of this commission was Hon. Carroll D. Wright, for many years United States Commissioner of Labor and now president of Clark College at Worcester, Mass. This commission was appointed by the governor of Massachusetts in accordance with an act of the legislature, and spent nearly a year in a study of the relation of children to our industries and the condition of industrial education at home and abroad. The commission found that "there

is a widespread interest in the general subject of industrial education, or special training for vocations," but that our people generally, and even those who are most interested in the subject, have no definite idea as to its proper scope or method. "Compared with the opportunities afforded in Europe for acquiring knowledge and skill in productive industry, the work now being done in Massachusetts is strikingly and painfully inadequate," and while in this country "the general public has been strangely blind to the narrowness of the public school education," in Europe there is "the universal recognition of the necessity of special education for every form of industrial life." One of the conclusions of the commission was that "the State needs a wider diffusion of industrial intelligence as a foundation for the highest technical success, and this can only be acquired in connection with the general system of education into which it should enter as an integral part from the beginning. The latest philosophy of education reenforces the demands of productive industry by showing that that which fits a child best for his place in the world as a producer tends to his own highest development physically, intellectually, and morally."

There seem to be two lines in which industrial education may be developed—through the existing public school system and through independent industrial schools. In regard to the former, the commission recommends that cities and towns so modify the work in the elementary schools as to include for boys and girls instruction and practice in the elements of productive industry, including agriculture and the mechanic and domestic arts, and that this instruction be of such a character as to secure from it the highest cultural as well as the highest industrial value; and that the work in the high schools be modified so that the instruction in mathematics, the sciences, and drawing shall show the application and use of these subjects in industrial life, with especial reference to local industries, so that the students may see that these subjects are not designed primarily and solely for academic purposes, but that they may be utilized for the purposes of practical life. That is, algebra and geometry should be so taught in the public schools as to show their relations to construction; botany to horticulture and agriculture; chemistry to agriculture, manufactures and domestic sciences; and drawing to every form of industry.

The commission would also recommend that all towns and cities provide by new elective industrial courses in high schools instruction in the principles of agriculture and the domestic and mechanic arts. * * *

The commission recognizes that there should be no interference with the public school system as it exists by a separate authority having coordinate powers with those of the board of education, yet it believes that the elements of industrial training, agriculture, domestic and mechanical sciences should be taught in the public schools, and, as already stated, that there should be, in addition to this elementary teaching, distinctive industrial schools separated entirely from the public school system. The foregoing recommendations, together with the bill embodying the views of the commission as to separate industrial schools, solves this problem.

Instruction in public elementary and high schools would naturally and logically lead to the entrance of students on the work of the independent industrial schools, and the Commission on Industrial Education, as recommended, would deal solely and entirely with such schools, leaving the school authorities on their own initiative to introduce new industrial courses in the public schools. * * *

In order to secure proper instruction for teachers in the elements of agriculture, there seems to be a necessity for some normal department or separate normal school. The commission has considered two propositions: One to establish a normal school in the agricultural college, and another to establish a separate normal school. The agricultural college has the plant and all the facilities for giving instruction in the elements of agriculture to those desiring to become instructors in such elements. It has therefore been considered the wiser plan to recommend a normal department in the existing agricultural college, thus saving expense and avoiding the necessity of duplicating plants. It is undoubtedly a fact that some of the seniors in the agricultural college are qualified to give instruction, thus utilizing the facilities of the college.

The latter recommendation of the commission has been approved by the general assembly of Massachusetts and an appropriation of $5,000 given to the Massachusetts Agricultural College to initiate its normal work. A further recommendation that a commission on industrial education be appointed to serve five years has been approved and Prof. Paul Hanus, professor of the history and art of teaching in Harvard University, has been appointed chairman.

In New York at the annual meeting of the State Association of School Commissioners and Superintendents, held at Cornell University in October, 1906, the best means of adapting rural schools to their environment was discussed, and it was generally agreed that agriculture should be taught as a part of the general scheme of pedagogy, of which it should be the basic factor.

In Indiana the county superintendents in twelve counties have organized clubs for the study of crops, and the Association of County Superintendents has asked Purdue University to organize a training school for teachers in agriculture and nature study.

At the annual meeting of the department of superintendence of the National Educational Association held in Louisville, Ky., in February, 1906, O. J. Kern, superintendent of schools of Winnebago County, Ill., presented a paper upon The Form of Industrial Training Most Practical and Best Suited to the Country Child. A round-table discussion on agricultural education was held during one afternoon and evening, at which there was general agreement as to the necessity for introducing agricultural study in some form into the public schools, and that this may be efficiently done opportunity must be afforded teachers to receive instruction in agriculture in the normal schools.

The committee of the round table appointed to draft resolutions summed up the points agreed upon in the following declarations, which were afterwards adopted by the department of superintendence:

Resolved, That the department of superintendence of the National Educational Association is in hearty accord with that part of the report of the Hon. James Wilson, Secretary of Agriculture of the Untied States, in which he encourages the teaching of elementary agriculture in the public schools, and respectfully requests Congress to grant the appropriation of $13,620 which he has asked for to enable him to investigate and report upon the progress and present condition of agricultural instruction and institutions in this and foreign countries.

Resolved, Second. That since it is essential to the successful teaching of industrial subjects in the public schools that the teachers shall first be trained for this work, we urge the State normal schools to give special attention to instruction in elementary agriculture, manual training, and domestic science.

Resolved, Third. That in order to meet the extraordinary expenses of properly equipping these schools for giving this instruction we urge the adoption of the Burkett-Pollard bill now before Congress making appropriation to the States for this purpose.

In California at a joint meeting of the State Teachers' Association and the State Farmers' Institute, held at the University of California in December, 1905, and attended by some 7,000 persons, the subject of agricultural education was discussed from various points of view, and as a result of this meeting a committee was organized to promote the interests of such education in the public schools of the State.

At a conference for education in the South, held at Lexington, Ky., in May, 1906, and attended by leading educators from a number of States, much attention was given to the claims of agriculture to a place in the school curriculum. A similar conference on secondary education in the South, held at the University of Virginia, devoted one whole session to the discussion of problems involved in introducing agriculture into the public schools. It developed that much thought is being given to these matters by professors of secondary education in the universities of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia.

At the meeting of Virginia State Teachers' Association and affiliated organizations in November, 1906, the teaching of agriculture in the public schools was widely and thoroughly discussed, and President Alderman, of the University of Virginia, in the closing address of that great meeting, declared that among the things which should be considered as settled in the campaign for a better school system now being actively carried on in that State was that agriculture in some form should be generally taught in the schools.

The examples given are sufficient to show the trend of thought in educational bodies assembled to consider general educational problems. The meetings during the year of associations primarily agricultural have been marked by even more earnest discussion of the elementary phases of agricultural education. During the last six months of 1906 no less than five national agricultural organizations discussed these matters and adopted resolutions calling upon Congress for additional funds to enable the Office of Experiment Stations to promote the extension of farmers' institutes and agricultural instruction in schools. These organizations were the Farmers' National Congress, the Association of American Agricultural Colleges and Experiment Stations, the American Association of Farmers' Institute Workers, the National Grange, and the Graduate School of Agriculture. The Farmers' Congress of Texas adopted resolutions calling upon the State legislature to enact laws to bring about the introduction of elementary agriculture into all public schools of the State.

PUBLICATIONS.

The year has been productive of numerous American text-books, manuals, and works of reference suitable for use in college classes in agriculture. Among books of this kind received at the Office of Experiment Stations are the following:

Cotton: Its Cultivation, Marketing, Manufacture, and the Problems of the Cotton World. By C. W. Burkett and C. H. Poe.

A popular discussion of the subject of cotton in all its economic aspects from the preparation of the land to the final disposition of manufactured cotton fabrics.

Clovers and How to Grow Them. By T. Shaw.

A general description of the clover plant and popular directions for the growing of clovers, with an entire chapter devoted to each of the more important varieties and species.

How to Make a Fruit Garden. By S. W. Fletcher.

The planting, care, harvesting, and storing of common orchard small fruits; methods of treating insect pests and fungus diseases. Formulas for spraying material and grafting wax, and rules for the exhibition of fruits are among the topics treated in this work.

The Seed Grower. By C. Johnson.

Gives detailed directions for the production of all different kinds of vegetable and flower seeds commonly grown in the United States.

Soil Physics and Laboratory Guide. By W. H. Stevenson and I. O. Schaub.

This book, which is the outgrowth of the laboratory instruction given at the Iowa Agricultural College, presents a series of carefully outlined experiments in soil physics.

Soils. By E. W. Hilgard.

This is a volume of over 600 pages embodying the matured fruits of a long and varied experience, generally under pioneer conditions, in both humid and arid regions. The book includes a discussion both of the methods and results of direct physical, chemical, and botanical investigations, as well as the subject-matter relating to the origin, formation, classification, and physical and chemical nature of soils.

Soils and Fertilizers. By H. Snyder.

This is the second edition of "The Chemistry of Soils and Fertilizers," which has been entirely rewritten, new material added, and the laboratory practices made more prominent.

Profitable Stock Feeding. By H. R. Smith.

Presents the results of investigations and experience in stock feeding in such a way that they may be of use to the student and investigator as well as to the stock raiser. Not only stock feeding, but stock raising, milk production, the care and management of beef cattle, sheep, pigs, farm poultry, and horses are discussed.

The American Standard of Perfection.

A manual for judging domestic poultry, including chickens, ducks, turkeys, and geese, published by the American Poultry Association.

Profitable Dairying. By C. L. Peck.

Published as a practical guide to successful dairy management and includes chapters devoted to the physiology of milk secretion, dairy breeds, feeding cows, milking, care of milk, butter making, and similar topics.

Modern Methods of Testing Milk and Milk Products. By L. L. Van Slyke.

A book prepared for the use of dairy students, butter makers, cheese makers, milk inspectors, etc., rather than for the chemist, and the methods described are such as would not necessarily require previous chemical training for their successful operation.

Diseases of Swine. By R. A. Craig.

This is a volume in which an attempt has been made to bring together the known facts relating to the common diseases of pigs, particular attention being given to the serious infectious and parasitic diseases.

The Microscopy of Vegetable Foods. By A. L. Winton.

This summarizes the results of a large number of original investigations and is designed for the use of food analysts, agricultural chemists, pharmacists, and others engaged in the examination of foods.

A Complete Course in Canning, published by The Trade, Baltimore.

A book giving detailed formulas for the canning and preserving of all the vegetables, meats, fruits, fish, and soups commonly canned, as well as data for making jams, jellies, mince-meats, pie filler, spice mixtures, etc.

Primer of Irrigation. By D. H. Anderson.

This is a volume intended to aid those who are beginners in irrigation farming.

Sanitation of a Country House. By H. B. Bashore.

A short nontechnical treatise on the sanitation of the American country home.

How to Choose a Farm. By T. F. Hunt.

Deals with the selection, arrangement, and management of a farm from the standpoint of making a profit.

Two text-books on Farm Accounts have been published, one by H. L. Steiner, of Toledo, Ohio; and one by J. A. Vye, of the Minnesota College of Agriculture.

The literature of nature study and elementary agriculture has also been augmented considerably. The New York State education department has published a course of study and syllabus for elementary schools which contains an outline for nature study in the first six years of the elementary course and agriculture in the remaining two years. The State superintendent of public schools in Wisconsin has issued a manual for the common schools of that State which contains an outline course in elementary agriculture. A similar course for the common schools of South Dakota has been published, also a course in nature study for North Carolina schools.

A guide for school and home gardens has been published under the title of "Hints and Helps for Young Gardeners," by H. D. Hemenway, formerly director of the Hartford School of Horticulture.

Elementary Agriculture with Practical Arithmetic, by K. L. Hatch and J. A. Haselwood, is a text-book of agriculture suitable for use in elementary schools, which treats in a brief but logical way of plant and animal production and devotes some space to farm mechanics and economics.

The feature which distinguishes this text-book from any other that has appeared in this country is the nature of the practicums, which consist of problems in agricultural arithmetic. There is a total of 274 of these problems, of which there are from 6 to 24 following each chapter and related to the subjects discussed in that chapter. There are also scattered through the text numerous tables taken from the publications of this Department and adapted to the needs of the text-book, as well as numerous references to the bulletins and other publications of this Department.

How to Teach the Nature Study Course. By J. Dearness. A text-book prepared to aid the teachers of Nova Scotia, Ontario, and Manitoba in presenting the prescribed school courses in nature study and school gardening.

The Office of Experiment Stations has made two contributions to the literature of elementary agriculture, (1) a bulletin on School Gardens, by B. T. Galloway, containing a report of the school garden work in the District of Columbia, conducted in a cooperative way by this Department and the normal schools of the District, and a report on school gardens in different cities in the United States visited by Miss Susan B. Sipe; and (2) a Yearbook article on the Use of Illustrative Material in Teaching Agriculture in Rural Schools, by D. J. Crosby, in which the writer discusses the value of agriculture in rural schools, describes methods employed in teaching this subject in a number of schools, and gives suggestions for a number of simple exercises in elementary agriculture.

At the request of a committee appointed at a meeting of the State Teachers' Association and the State Farmers' Institute at Berkeley, Cal., December 26–29, 1905, a suggestive course of nature study and elementary agriculture for the schools of California was prepared by A. C. True and D. J. Crosby, of the Office of Experiment Stations. This course was published in two numbers of the Western Journal of Education, but nearly the whole issue of the first number was destroyed by fire at the time of the earthquake in San Francisco. For the purpose of making the article available for teachers, therefore, its essential features are given below.

NATURE STUDY AND AGRICULTURE FOR THE ELEMENTARY PUBLIC SCHOOLS.

At the joint meeting of the State Teachers' Association and the State Farmers' Institute held at Berkeley, December 26–29, 1905, one of the writers of this article presented some of the reasons "why the

friends of agricultural progress believe that agriculture should and will be taught in the public schools,[a] and outlined a general system of agricultural education for California from the university down to the elementary school. We have since been asked to discuss somewhat more in detail the topics which should be included in nature study and elementary agricultural instruction and the methods which should be followed in this work. We have consented to do this, not with the expectation of setting forth a complete system of nature study and elementary agriculture exactly adapted to the requirements of California schools, but rather in the hope that a more definite outline of these subjects will call forth further study and discussion of these matters by California school officers and teachers with the result that the attempts at such instruction now being made in different parts of the State may be brought more largely to public notice and that others may be encouraged to undertake experimental efforts in this line in the schools under their direction.

For this whole subject is still in an experimental stage. What is feasible and proper in one part of the United States or in one part of a State may not be at all adapted to the conditions elsewhere. It is especially desirable now that this matter is being widely agitated that we should have during the next few years a large number of experiments in different localities which may result both in establishing some general principles on which such instruction may be safely based, and also in developing the especial requirements of different regions for this kind of educational effort.

Fundamentally the teaching of nature study and elementary agriculture in the primary schools is an attempt to educate the child through his environment. Theoretically it might be desirable to make the natural environment of the pupil the basis for his education along all lines, and it is possible that this may be done in our schools generally when our educational system has further developed and our educational ideals have more completely changed. We should not, however, wait for such an evolution of pedagogy to be completed, but, taking our present school system with all its faults in theory and practice, we should attempt to devise a practical modus vivendi for nature study and elementary agriculture along with the other subjects usually taught in our common schools. In doing this we should not leave out of sight the desirability and importance of correlating the new subjects with the old ones. It would be strange, indeed, if nature study and agriculture should gain a firm foothold in our public school curriculum without materially affecting and even improving the instruction in English, arithmetic, geography, etc. It is hoped that the new subjects will in a few years so unite themselves in bonds of friendship

[a] This address has been published as Circular No. 17 of the California Agricultural Experiment Station, and may be obtained on application to the station at Berkeley.

with the old ones that they will be no longer regarded as interlopers, but rather as boon companions and helpers. Meanwhile we should present the most reasonable scheme for the introduction of the new subjects and seek to avoid all unnecessary friction in establishing their relations with old subjects.

Scarcely anybody denies or doubts that both agriculture and agricultural people would be greatly benefited if nature study and the elements of agriculture were taught efficiently in public schools, especially all schools attended by country pupils. Moreover, those students of education who have taken the trouble to familiarize themselves with rural conditions, and those particularly who have had actual experience in teaching nature study and agriculture, are practically agreed that for rural school pupils these subjects possess marked educational value.

It is not necessary, or even desirable, for country pupils to isolate themselves entirely from country things for six hours a day for one hundred and sixty days in a year for eight or ten years in order to prepare for life in the country. On the contrary, as Professor Hanus, of Harvard University, has so well said, "the only real preparation for life's duties, opportunities, and privileges is participation in them so far as they can be rendered intelligible, interesting, and accessible to children and youth of school age; and hence the first duty of all education is to provide this participation as fully and freely as possible."

With reference to nature study and agriculture in the public schools, then, the question is not so much one of desirability as of feasibility. Is it practicable, considering the present condition of country schools, to teach these subjects? Many writers and speakers are ready to say no, and to produce evidence and elaborate arguments in support of their contention; but all of their evidence and arguments are of no more avail in this connection than was the alibi established by the lawyer defending a man accused of stealing a pair of trousers. By means of the sworn testimony of several witnesses, supported by skillful arguments, he had established an alibi which seemed to be impregnable until counsel for the prosecution brought out the fact that the prisoner at the bar was at that moment wearing the stolen trousers. Many teachers, though by no means as many as we might wish, have already taught nature study and agriculture with sufficient success to warrant the conclusion that the obstacles are far from insurmountable.

In overcoming these obstacles one of the most pressing needs is the preparation of more teachers; another is the preparation of courses of study sufficiently simple to be of immediate service to untrained teachers who desire to take up a little work along this line, and yet based upon sound pedagogic principles and sufficiently elastic to serve as a foundation for more satisfactory courses later on. It is our present purpose to set forth in a general way the topics which might be

included in such a course of study, the character of instruction, and the sources from which information can be secured concerning the details of the work.

For convenience the eight grades preceding the high school may be divided into three groups, as suggested by Prof. B. M. Davis in his bulletin on School Gardens for California Schools. Group I includes grades 1 to 3, children 6 to 8 years old; Group II, grades 4 to 6, children 9 to 11 years old; and Group III, grades 7 and 8, children 12 to 14 years old. The work of the first two groups should consist largely of nature study, supplemented by school garden work; that of the third group, elementary agriculture, with illustrative practicums or experiments. In general the work may be divided as shown in the following table:

Nature study and agriculture, by groups.

Group.	Character of instruction.	Garden.
I. Nature study. Children 6 to 8 years old.	OBSERVATION: Observe wild and cultivated plants, trees, insects, and wild and domestic animals in environment at home and near school.	School garden: Plant and grow some of the common hardy vegetables, such as radishes, lettuce, beets, and carrots; and one or two quick-growing flowers, such as dwarf nasturtiums.
II. Nature study. Children 9 to 11 years old.	OBSERVATION and COMPARISON: Observe weather, soils, wild and cultivated plants, trees, insects, and wild and domestic animals in environment of school district and vicinity; compare habits of plants and animals in order to become familiar with their different modes of living, their struggles for existence, and their uses to man.	School and home gardens: Plant and grow typical economic plants of the region, giving some attention to different varieties, and to the relation of crops to different conditions of soil, weather, treatment, etc.
III. Agriculture. Children 12 to 14 years old.	OBSERVATION, COMPARISON, and JUDGMENT: Study objects as above, within and beyond horizon of children's observation; introduce textbooks and reference books on elementary agriculture as sources of information concerning objects beyond the limits of personal observation; illustrate processes by simple experiments; study different types of plants and animals; visit typical farms; teach sources and uses of agricultural literature—books, bulletins, and farm journals.	School and home gardens: Plant and grow different varieties of crops—e. g., wheat, barley, sugar beets, potatoes; introduce exercises in pruning, grafting, making cuttings. Encourage pupils to grow crops, poultry, and farm animals at home, keeping account of labor, fertilizers, feed, gross and net returns, and have them experiment on different methods of planting, cultivating, harvesting, and preparing for market.

NATURE STUDY.

GROUP I.

As indicated in the above outline, the nature study work of the first three years should largely consist of observations, directed to a certain extent by the teacher, the object of which is to extend the children's acquaintance with the birds, insects, flowers, trees, and other animal and plant life in their immediate environment—in the school yard, at home, and along the roadside. This very pleasant and profitable way of gaining knowledge has been their principal occupation during the two or three years that they have been running

about out of doors at home, and they should be encouraged and aided to extend their knowledge of the things in nature with which they are likely to come in daily contact throughout their lives.

How many last year's birds' nests between home and school? What kinds? How many and what kinds of flowers, trees, bushes, birds, animals, insects? What kinds of animals on the home farm, and their uses? What plants are raised, and their uses?

These questions are merely suggestive. They may be modified or expanded almost indefinitely to suit local conditions. If time for nature-study exercises is limited the recitations can be conducted wholly in connection with the other regular class work. In the language class the pupils should be led to tell and write about the different objects seen; in the spelling class they should learn to spell the new names; in the number class they would find keen enjoyment in working out problems based on such familiar concrete material.

The teachers should also go with small groups of children on short walks around the school yard and along the roads on the occasional noon intermissions, and on longer trips into the fields and woods on Saturdays. Each trip should be taken with some leading object in view, such, for example, as a search for early spring flowers, or cocoons, or grasshoppers, or weed seeds; but this leading object should not shut the eyes of the children to other things. Direct their observations, but do it in such a way as to stimulate their perceptive faculties. Let them see and hear and feel and smell. Tell them little; they should do the telling. Better wait days and weeks for an answer from the children than tell them now and rob them of the pleasure of discovery, provided the subject is within their comprehension. At first there will seem to be but little connection between the different observations made by the children, but the teacher should never lose sight of the fact that very real and definite relationships exist between the different plants and animals of a given locality and between these things and their inorganic environment. Gradually, therefore, these relationships and the relation of all these things to man should be brought out.

In nature study as in other school work, the teacher should have a definite plan of instruction in which the educative effect of the work on the child's mind should be carefully considered. This plan need not be revealed to the child, and much less should it be reduced to written or printed form for him to learn. It is well, however, for the teacher always to remember that while it is comparatively easy to interest and excite a child, it is more difficult to both interest and instruct him. Book work and the ordinary formalities of learning and reciting set lessons should be excluded from nature studies. The problem is to take advantage of the spontaneous curiosity of the child and so direct it by a subtle and unperceived guidance that the

charm of original quest and discovery of natural objects and phenomena will not be lost and that the finding of one thing will lead on to the finding of another until at length the child realizes, though it may be unconsciously, that the secrets of nature are united one with another in most delightful and useful ways. The pupil's individuality of interest, thought, action, and expression should also be cultivated and strengthened, while accuracy of perception, execution, and statement should at the same time be stimulated.

Every school should have connected with it a school garden where the smaller children can grow vegetables and flowers of easy culture and the larger children can try simple experiments. The garden work of the first group should be confined to planting and caring for a few quick-growing vegetables and flowers, with only such problems as arise incidentally in connection with the work of growing plants. Concerning the relation of such work to nature study Davis says:[a]

> All the processes of gardening are preeminently nature studies of the very best sort. To rear a plant successfully, to be responsible for its life, to protect it and minister to its needs, to become thus vitally connected with it, go a long way toward giving the child the right attitude toward nature. This attitude or point of view, or means of contact is, indeed, the chief purpose of nature study. This attitude is fundamental for any development of an æsthetic appreciation of nature. To rear a plant with all its beauty of leaf and flower, if not creative art, has at least the elements of it, and leads to more than a passive enjoyment of the beautiful.

The value of a plant will be greatly enhanced in the estimation of a child if he is the sole owner of it; hence it will probably be found best to supply a small garden for each child. A garden containing 8 to 12 square feet will do for the children in Group I. At the same time the opportunity to bring out the value of cooperative endeavor should not be lost sight of, and provision should be made some time during the course, if possible, for group gardens or class gardens, either to include all the garden work of a class or group for one season, or to be confined possibly to work on demonstration plats of economic plants.

The work outlined above furnishes an excellent basis for the study of home geography, which is usually begun in the third year, and which will probably include oral work concerning the surrounding farms, vineyards, orchards, and gardens; the gristmill, sawmill, creamery, and canning factory; the streams, lakes, roads, railroads and trolley lines; the churches, schools, libraries, and places of amusement; in short, all the more important local industries and commercial and social institutions. Nature study may also be correlated closely with home geography. The two may be carried on together in much the same way as was suggested above for nature study, language, numbers, and spelling.

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[a] School Gardens for California Schools, p. 42.

GROUP II.

As the pupils advance from one grade to another their nature study work should be better systematized, their observations should include more details, and greater attention should be given to the comparison of physical and other readily-discerned differences in the species. Besides being more thorough, the nature study survey should be extended somewhat beyond the limits of the school district, and some study should be made of life histories of plants and animals, so that these may be recognized in all stages of their development and their economic relations determined. This will enable the pupils to decide whether a given species is mainly beneficial or harmful and will set them to thinking about means of perpetuating or exterminating the species. This last consideration is the one which mainly determines the attitude of the farmer toward his field crops, domestic animals and fowls, as well as toward the weeds and other pests that annoy him.

To illustrate by a specific example: It would be interesting to study and compare the teeth of different animals, such as the cow, horse, cat, squirrel, and mouse, not for the purpose of discovering anatomical curiosities or cataloguing specific markings, but for the purpose of getting at the food requirements of these different animals, and the ability of a given animal to survive under given conditions. A dog would starve in a rich pasture where a cow would thrive. Why? Moles, shrews, and field mice occupy the same underground tunnels in our lawns. The first two eat grubs, worms, and other insects and do no harm except to raise unsightly ridges on the lawn. The field mice, on the other hand, eat our crocus and jonquil bulbs and the tender roots of our rose bushes and other shrubbery. Examine the teeth of these different burrowers. What differences that would help to account for their habits?

When the nature study teacher and her pupils have arrived at this point of view, where the different objects are studied, not as curiosities, but as components in a complex environment, each element of which has its own function to perform, a definite influence upon all other factors, they will be in a position to pass over as unimportant such details as color of hair, length and number of teeth, number of leaves, length of petioles and internodes, and a hundred other peculiarities of plants and animals, except as these peculiarities have a direct bearing upon the perpetuation of the species or upon their usefulness or harmfulness to man. Such a point of view and such an attitude it is desirable that the pupils should reach before they take up the more formal study of agriculture, which is pursued "for the purpose of finding out how to enhance the animal and plant values to man."

The school garden work should be continued but more attention should be given to important economic plants and varieties of each; to selected seed; to the influences of climate, soil, cultivation, and irrigation; and to the work of birds and insects. The correlation of nature study and gardening with composition, arithmetic, geography, drawing, and other subjects should also be kept in mind. Every California teacher should have a copy of Davis's School Gardens for California Schools, which discusses in considerable detail the value of school gardens, the character of work to be undertaken, and the correlation of gardening and other school work. This and other aids for teachers of nature study are mentioned in the list below:

SOME HELPFUL NATURE STUDY AND SCHOOL GARDEN PUBLICATIONS.

School Gardens and Their Relation to Other School Work. W. A. Baldwin (Amer. Civic Assoc., Dept. Children's Gard. Pamphlet 2, pp. 15, figs. 6).

Suggestions are given for correlating school garden work with arithmetic, language, drawing, and other subjects. Additional references to school garden publications are given.

The School Garden. By L. C. Corbett. (Washington: U. S. Department of Agriculture, Farmers' Bulletin No. 218, 1905. Pp. 40, figs. 33. Free.)

Contents: Introduction, value of school garden work, the individual school garden, laboratory exercises, window boxes for schoolrooms, specimen plants for schoolrooms, and the decorations of school grounds. Under the individual school garden the topics treated are types of plants for the garden, a vegetable garden, rotation of crops, combination vegetable and flower gardens, cultural suggestions, vegetables, and flowering plants. The laboratory exercises include studies of soils, plants, cuttings, grafts, and budding. Under the decoration of school grounds consideration is given to the plan, walks, lawns, annual plants suitable for school grounds, and trees and shrubs suitable for school grounds and classified by sections of the country where they will grow most readily.

A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools. By Dick J. Crosby. (Washington: U. S. Department of Agriculture, Office of Expt. Stas. Circ. 52. 1903. Pp. 4. Free.)

This circular gives a list of (1) a few books which will aid the teacher who is beginning nature study work, (2) supplementary aids for the teacher, (3) interesting nature studies for pupils, (4) up-to-date elementary texts on agriculture suitable for pupils in the grammar school and the high school, and (5) publications which might serve as the nucleus for a public school agricultural library.

School Gardens for California Schools. By B. M. Davis. (California State Normal School, Chico, Bul. 1, pp. 79, figs. 11, chart 1. 50 cents.)

This is a manual for teachers based on experiments in school garden work at the Los Angeles and Chico State normal schools. The author deals briefly with the history

and development of school gardens and their educational value; devotes a chapter to the plant and its relations, including soils, fertilizers, temperature, and plant enemies, with an annotated list of some of the most common and important insects of California; another chapter to plant propagation, in which is included a plant calendar containing condensed information concerning quite a variety of vegetables, flowers, and climbing plants; a third chapter to instruction, including practical work and correlative subjects; a brief description of school gardens at Los Angeles and Chico; an abridged list of useful books and bulletins for a school library; references to literature on insects mentioned in the text, and a bibliography of 218 entries on school gardens, nature study, elementary agriculture, and horticulture. An appendix contains "some exercises for experimental study of soils and other factors of plant growth."

School Gardens. By B. T. Galloway. (Washington: U. S. Department of Agriculture, Office of Expt. Stas. Bul. 160, 1906. Pp. 47, pls. 5.)

A report is given on the school garden work in the District of Columbia, conducted in a cooperative way by this Department and the normal schools of the District, under the direction of the Bureau of Plant Industry and Miss Susan B. Sipe, instructor in botany in Normal School No. 1. The garden work described includes the boys' vegetable gardens on the grounds of this Department, the home gardens of the normal school pupils, and the improvement of school grounds at Normal School No. 1, and 32 other schools in the District. Supplementary to this report is a report by Miss Sipe on school gardens visited by her in the summer of 1904 in Hartford, Conn.; Boston, Brookline, Hyannis, and Worcester, Mass.; St. Louis, Mo.; New York City, Yonkers, and Rochester, N. Y.; Cleveland, Ohio, and Philadelphia, Pa. Throughout the bulletin an effort has been made to bring out the educational trend of garden work in the different enterprises described.

How to Make School Gardens. By H. D. Hemenway. (New York: Doubleday, Page & Co., 1903. Pp. XVI + 107, pls. figs. 16.)

This is a popular work dealing with the details of making a school garden, such as laying out beds, planting seeds, sowing seeds in window boxes, making cuttings, and grafting and budding. A bibliography of school garden literature is appended.

Nature Study and Life. By C. F. Hodge. (London and Boston: Ginn & Co., 1902. Pp. 514, pl. 1, figs. 196.)

This is a practical treatise on nature study, the subject being treated from the standpoint of living things. It contains a vast amount of suggestive and useful information regarding domestic animals and native plants, insects, birds, and lower forms of animal life. Much of it has an agricultural and economic bearing. Thus, detailed directions are given for the growing of an apple tree, peach tree, grapevine, etc., from the planting of the seed to the grafting or budding of the plants, and the after treatment as fruit trees. A chapter on our common birds is considered from the standpoint of what birds do, and their value in the community and to farm life is clearly brought out. Most of the insects treated are those directly related to our orchard, garden, and field crops, and to the household. A chapter is given on elementary forestry, and another on flowerless plants like ferns, mosses, and mushrooms. A final chapter contains suggestions for lessons with plants and animals, suited to the different grades in the school.

Children's Gardens. By Louise Klein Miller. (New York, Boston, and Chicago: D. Appleton & Co., 1904. Pp. 230, il.)

This book discusses school gardens as a factor in education and shows the sociological and economical significance of the training they afford. It gives detailed directions for planting and caring for school gardens in both city and country, with

concrete examples in actual practice, including tree planting, hedge growing, and herbaceous borders, with chapters on wild flowers, vegetables, window gardens, roof gardens, propagation, grafting and budding, soils, fertilizers, insect pests, birds, and implements. The appendix contains lists of shrubs, trees, and flowers for the wild garden, and ferns, bulbs, etc., for cultivation.

Progress in Agricultural Education, 1903. By A. C. True. (Washington: U. S. Department of Agriculture, 1903. Pp. 63, il. Free.)

This article includes the report of the school garden committee of the American Park and Outdoor Art Association, with additional illustrations and plans. It can be had upon application to Dr. A. C. True, Office of Experiment Stations, Washington, D. C.

AGRICULTURE.

GROUP III.

Pupils in Group III (grades 7 and 8) should continue to study and compare weather conditions, soils, plants, animals, and other natural phenomena and objects both within and beyond the limits of their personal observation. As sources of information concerning things not coming under their immediate observation or experience, the pupils should use a well arranged up-to-date text-book of agriculture and have access to good works of reference. If the nature study work outlined for Groups I and II has been carried out in the proper spirit—that is, if the pupils have been treated as seekers after truth rather than receptacles for the teachers' overflow of mental pabulum, they will not look upon text-books, bulletins, encyclopedias, and other available agricultural publications as additional tasks to be mastered, but as aids in extending their knowledge of things and affairs directly related to their life work. Most country boys of 12 expect to make farming their vocation; many at this age have already begun to raise small patches of pop corn or potatoes, or are the possessors of a sheep, or a calf, or a colt. Such boys will need no prodding to induce them to take up and study in an orderly way one of the attractive modern text-books of agriculture.

A text-book will be necessary in most cases as a more or less definite guide for the teacher who will in all probability be without special training in agriculture, and it will serve the further purpose of showing to parents what such instruction really involves. At the same time the limitations of text-books should be kept in mind. Publishers and authors in attempting to put out text-books sufficiently elementary for use in public schools, have been compelled either to treat the different topics in a very superficial way, or to prepare a text-book suited to a comparatively limited area. In either case it will be desirable to supplement work with the text-book by a study of other text-books and manuals, encyclopedias, agricultural journals, and the publications of the United States Department of Agriculture and the agricultural experiment stations. Such supplementary study will also

serve to familiarize the pupils with sources of authentic information on agricultural subjects, and this is one of the most important accomplishments aimed at by those advocating the introduction of agriculture into the public schools.

The oral work of the class room should be supplemented in many ways. Agriculture is a subject which lends itself admirably to the laboratory method of teaching. It is rich in illustrative material, and more than almost any other subject of study, it may be made to draw upon and utilize the resources of the whole community for the material. There should be laboratory work at school, garden work at school and at home, and study of farm animals, irrigation and drainage systems, home water supply and sewage systems, buildings and fences, orchards and spraying machinery, rotations and other systems of cropping on the better farms of the district. Pupils should be taken to local dairies to study dairy animals and machinery, to creameries, cheese factories, and canneries to study methods of preparing farm products for consumption and shipment, to cold-storage plants to study the preservation of foodstuffs, to the butcher shop to study meat cutting, to the green grocer to learn methods of preparing fruit and farm products for market, and to the implement dealer to compare types of farm machinery. Clubs of boys should be organized for the discussion of agricultural topics and to give practice in parliamentary proceedings. School and county fairs have been found very efficacious in stimulating interest among children along agricultural lines. In some States the county and State fair associations have aided the movement for agricultural education by offering liberal prizes for the best displays of agricultural products grown by school children.

The time to be devoted to agriculture will necessarily vary in different schools, but it is believed that on the average not less than one hour a week during the seventh and eighth years will be required to make the class work and laboratory experiments effective. The time spent in visiting farms, factories, etc., will depend so much on local conditions that no reliable estimate of it can be made in this article.

OUTLINE OF COURSE.

The course in agriculture should include an orderly and progressive study of the elements of plant production, animal production, and dairying, together with brief and very elementary consideration of a few topics in rural engineering and rural economics.

In plant production we would first consider a few plants with reference to their structure and physiology—how they feed, grow, and reproduce. It would be well in this connection to select one plant that is reproduced from seed, one from bulbs, another from cuttings, etc., and to teach and give practice in grafting, budding, layering, and making hard and soft cuttings.

The second consideration is the environment of the plant—climate and soil in relation to plant growth. These have been considered in a general way in the nature study observations, but it is now time to study some of the more fundamental problems in the relation of light, heat, moisture and air (in the soil and above it) to plant development, and the problems of soil management, such as tillage, drainage, irrigation, enrichment, impoverishment, and cropping.

Next in order would be a more detailed study of some particular farm crop or fruit of local importance, such as wheat, corn, cotton, tobacco, hops, apples, oranges, pears, grapes, or olives. Devote some time to the classification of the crop and its varieties, but lay greater stress on its commercial importance, its culture and its uses. Bring out the importance of carefully selecting seed or stock, and dwell somewhat on methods of planting, cultivating, harvesting, and marketing, and on protection from insect pests, weeds, and diseases.

In the study of animal production we would bring out first the leading characteristics of the different types and breeds of horses, cattle, sheep, swine, and poultry found in the vicinity of the school, and then take up matters concerning the care and management of these animals. Some attention should be given to feeds, and under favorable circumstances some exercises in compounding rations could be given. Other topics of importance in this connection are water supply, exercise, shade, ventilation and cleanliness of buildings, and the preparation of animals and animal products for market.

Dairying is an industry of sufficient importance in most States to deserve special consideration in a course in elementary agriculture. The subject should be introduced by making a somewhat more detailed study of the dairy type of cow than was given under animal production. This should be followed by a study of milk, its composition, how determined, and relation to price; handling, and the relation of cleanliness, straining, aerating, and cooling to quality; and uses for consumption as milk or cream, for condensing, for cheese making, and for butter making.

Rural engineering in most of its aspects is considered too technical for pupils in the common schools, but in every community there will be some opportunity to examine the plans and structure of good types of buildings, fences, irrigation systems, etc., and to devote some time to drawing simple plans of farms, buildings, and other works. Advantage should also be taken of any opportunity to visit implement warehouses and have the structure, operation, and care of different types of farm machinery pointed out to the pupils. The importance of good roads, hygienic water supply, and sewage disposal should be emphasized.

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Most of the topics under rural economics are too broad to be included in a brief course in agriculture, or too complex for the comprehension of common school pupils. It is thought, however, that some of the general principles of marketing and farm accounts might be taught in this connection. Some of the topics which might be considered are marketing—preparation for market, choice of market, transportation, and method and cost of sale; and farm accounts—feed and milk records, crop records, breeding records, inventories, and bookkeeping.

Attention should also be given to the benefits which may come from cooperative effort in such matters as the construction and management of roads, irrigation and drainage systems, the prevention and eradication of weeds, injurious insects, or diseases of plants and animals. In fact, all the work of the rural schools should be conducted with a view of impressing the children with the great advantage which may accrue to farming communities if a reasonable independence of the individual can be combined with a harmonious concert of thought and action for the common good.

Regarding the division of time between the different branches of agriculture no definite allotment can be made which will be suitable for all conditions, but in schools devoting two years of three terms each to agriculture, a fairly satisfactory division of time would be two terms for plant production, two terms for animal production, one term for dairying, and one term for rural engineering and rural economics. In case agriculture is to be carried beyond the eighth grade for one or two years, the same general outline can be followed by giving more time to each branch of the subject and going more fully into its details. Such an extension of time would be valuable in that it would render feasible a much broader study of the literature of agriculture.

SUGGESTIONS FOR SIMPLE PRACTICUMS OR EXPERIMENTS.

The effectiveness of agricultural instruction in the common schools will depend largely upon the ability of the teacher to select and devise suitable exercises for the illustration of the different principles involved. The materials to be used in laboratory work may be expensive or they may be had for a few dollars. Two dozen empty tomato cans, three or four lard pails, a few baking-powder cans and covers, a lot of empty bottles, a few small wooden boxes, a collection of typical soils (clay, sand, loam, and muck or peat), and a few seeds of garden and farm crops will enable the teacher and pupils to perform a variety of experiments, illustrating important principles upon which the science and practice of agriculture are based, and will not cost a cent. If to this material the school board or the pupils will add by purchase at prices approximately as given, an 8-ounce glass

graduate (10 cents), 4 dairy thermometers (60 cents), 6 student lamp chimneys (90 cents), 12 5-inch test tubes, 100 5-inch filter papers (15 cents), a pint glass funnel (10 cents), a 4-bottle Babcock milk tester with test bottles, pipette acid measure and acid ($5), an alcohol lamp (25 cents), a kitchen scale with dial which will weigh from 1 ounce to 24 pounds (90 cents), 12 ordinary glass tumblers (30 to 50 cents), a small quantity of litmus paper, and a few ordinary plates, iron spoons, pie tins, etc., the school will be provided with an excellent equipment for laboratory exercises, and all at a cost less than $10.

With this material in the hands of the pupils and a teacher willing to experiment and learn with the pupils the ordinary rural schoolroom becomes a laboratory in which it is possible to determine the comparative temperature, weight, acidity, porosity, capillarity, and fertility of different soils; to test their water-holding capacity and the readiness with which they may be drained, and to show the effects of cultivation, mulching, and puddling on the moisture content and physical condition of different soils. As far as the training of the pupils in mathematics will permit, the results obtained in the laboratory exercises should be translated to field conditions, and the importance of the principles involved should be brought out by questions concerning their application to the practical operations of farming.

Most of the modern elementary text-books of agriculture contain suggestions for numerous exercises illustrating the principles of agriculture, and several of the agricultural colleges have published circulars and bulletins containing similar suggestions. In order to show the nature of material now available, we give below several exercises selected from a bulletin (Practical Studies in Agriculture for Public Schools) published by the school of agriculture of Purdue University, Lafayette, Ind.

STUDY 1.—*To illustrate the capillary power of soils.*

Apparatus needed.—Three or more lamp chimneys, or better, glass tubes, at least an inch in diameter—the longer the better; a shallow pan that will hold water, and at least two types of dry soil, a clay and a sand.

Procedure.—Tie a cloth over the bottom of each chimney or glass tube, so that the soil will not drop out. Fill one chimney with the sand, another with the clay, and a third with a cloddy soil. If more soils are used, fill a chimney with each soil. Set the filled chimneys in the pan and put about one-half inch of water in the bottom of the pan and keep some there all the time.

Note.—The soil used should be completely dried and if possible screened, so as to be fine and uniform.

Observations.—Note in which soil the water rises the faster. How many inches does it rise in a unit of time? Try to explain the cause of the different rates of rising. Why does the water not rise as rapidly in the cloddy soil? Does this experiment teach anything about preparation of the seed bed? Try to make an application of this experiment to farm conditions, especially to the subsoil. If you can have glass

tubes 3 feet long, you will get at the real truth, which the lamp chimneys will not show, because the water in the sand rises very rapidly for a short time, but it is later overtaken and passed by the water in the clay. Can you explain this result?

STUDY 3.—*To show the effectiveness of a dust mulch.*

Apparatus needed.—Two 1 or 2 gallon buckets or cans with holes in the bottom, and a quantity of soil. Also, a scale which will weigh 25 or more pounds. Both buckets should be alike in size.

Procedure.—Fill one bucket full of water-saturated soil. It is best to wet it as it is put into the bucket. Fill the other bucket with the same kind of soil in the same condition, except do not fill entirely full. Leave a depth of about 2 inches. Let the buckets stand a day or two until they have drained. Then fill the one to the top with loose dry soil. This soil need not be very finely pulverized. Press down the surface of the other bucket so that it is rather compact. Weigh both buckets and make a note of the weights. Keep the buckets in any conveniently warm place, or in fine weather set them out of doors. Weigh the buckets every three days for two weeks. Keep records of the weights.

Observations.—Under which condition is the most weight lost? What is this loss in weight? To what is it due? Make the application to farm practice. Calculate what the loss in moisture amounts to in tons of water per acre of area. How many inches of rainfall does this represent? Will it pay to keep the top soil loose in the cornfield in July and August?

STUDY 9.—*To show the germination of seeds.*

Apparatus needed.—Two, four, or more dinner plates; two, four, or more pieces of canton flannel, 4 inches square, and some seeds for testing, say corn and beans.

Procedure.—Dampen the cloths and lay one on a plate; upon this put twenty-five of each kind of seeds to be tested. Put a second cloth over these seeds, having it pretty wet. Over all, turn a second plate to prevent evaporation. Fix as many sets of plates and as many kinds of seeds as you wish. Watch the cloths that they do not become too dry. Also, be careful not to make them too wet. Keep at a temperature of 70 to 85° F.

Observations.—Note the time elapsing until the seed coats begin to burst. Which part of the new plant appears first, the root or stem part? Is there any difference in the disposition of the cotyledons (seed leaves) in the different kinds of seeds? Look for the root hairs; what do you think their office is? Find the hardened cap at the end of the root; this is the root cap. What do you think its office is? What is the first step in germination? Does the process of germination teach anything about the preparation of the seed bed? Calculate the per cent of seeds that germinate. Try seeds of different ages. Do the germs of all the seeds of the same kind show the same degree of activity? Why not? Can you tell whether a kernel of corn will grow by examining the germ? If you can not, get some one to show you. This, however,is not as accurate as the germination test.

Note.—This exercise has a very practical use to the farmer. Much time, labor, and money would be saved each year if farmers would test their seed corn as well as other seeds. To test seed corn, divide the corn to be tested into lots of ten ears each. Take five kernels from different parts of each ear and treat them as above, using one plate for each ten ears. If four or more kernels on a plate fail to germinate, the entire ten ears should be thrown out or each ear tested by itself. Instead of plates, the kernels may be placed on pieces of paper and the ends folded over and a number of these folders placed in a cigar box where they can be kept moist and be easily examined.

STUDY 24.—*Using the Babcock test for butter fat.*

Because of its simplicity, accuracy, and ease of operation, the Babcock test has become the standard test for determining the value of milk and cream as delivered to the cheese factories and creameries all over the country. It is also largely used by private individuals who keep cows, to determine whether a cow pays for her keeping or not.

A good tester can be obtained from almost any dairy-supply dealer at a small cost. Directions for using come with the machine. Have some pupil bring a sample of milk from one of the cows at home. The sample should be taken after the milking is done and the milk has been poured two or three times from one bucket to another, so as to be thoroughly mixed. (Make a note of how much the cow gave at that milking, either weigh or count a gallon as 8¼ pounds.) Take about a half cupful as a sample and put into a clean bottle. From this bottle the sample is drawn for testing, after mixing the contents of the bottle thoroughly.

Having determined the per cent of butter fat in the sample, an estimate can be made of the total amount of butter fat in the milk from which the sample was taken. Make several tests of the same cow's milk, using both morning and evening milk. Note variations. Estimate how much milk this cow gives in a year and calculate the number of pounds of butter fat produced. A pound of fat in ordinary practice should make about 1.1 pounds of butter. What price per pound do you get for butter? Does the cow pay for her feed? The cow should not be condemned until many tests have been carefully made, and you are sure you are right.

Test samples of skim milk, buttermilk, and cream. Determine the amount of fat lost in different methods of separating cream, e. g., separator, shallow pan or crocks, or deep cans set in cold water.

If you are in a dairy district, or where people are interested in making their cows pay for their keeping, this exercise will furnish work for several weeks and may be made profitable to your patrons as well as to your pupils. The making of a test of a few samples need not occupy more than a half hour and the cost of each test is less than one cent.

STUDY 25.—*The effect of temperature on the creaming of milk.*

Select two bottles of the same size and shape; quarts are large enough, preferably with long slanting necks and made of white glass so that the layer of cream may be seen. Have some one of the children bring enough milk to fill both bottles. This milk should be milk drawn on the morning of the day on which it is brought, if possible. Mix thoroughly, preferably by pouring from one vessel to another two or three times; then fill both bottles to within an inch of the top, place one in a pail of water at a temperature as near 40° F. as possible, and put where it will stay near that temperature. Put the other bottle in a pail of water at a temperature of 75° F. and keep it there. At the end of two hours, and each two hours throughout the day, measure with a ruler or a strip of paper the depth of the cream line on each bottle.

Notice the difference in the depth of the cream line, and whether it increases or decreases as the bottles stand. On which one does the line stand most clearly? Why does cream rise? Can you explain the difference in the effect of the two conditions of temperature?

Note.—This last point is a disputed question, but you are entitled to your own opinion. What does this exercise teach you about setting milk away for the cream to rise?

This bulletin contains twenty-seven experiments for school study and fifteen experiments for home study. One of the latter, prepared by Prof. H. E. Van Norman, is given herewith:

EXPERIMENT 15.—*A study of the influence of cleanliness and cold on the keeping quality of milk.*

Select a cow whose udder is not particularly clean and whose sides and flanks have not been cleaned. Milk about a quart or so of milk in the usual way, then stop and brush off the sides, flank, and udder of the cow thoroughly, and wipe the udder and adjacent parts with a damp cloth, not wet enough to drip, then with clean hands and clean dry pail milk another quart or so.

Have two clean fruit jars, either pint or quart, washed and scalded; fill one with milk drawn before cleaning the cow, and set it away in pantry, kitchen, or cellar at ordinary room temperature.

Fill the second jar with milk drawn after brushing and wiping the udder and place the jar in a bucket of coldest well or spring water obtainable. If possible take temperature of each jar of milk, of the water, and the room. At the end of twelve hours taste each lot of milk and make note of its condition as to sweetness and flavor. If you have learned to use the acid test at school, test the two lots by means of it. Your observations will then be more accurate. Note temperatures of each lot, of room, and of water, then put fresh cold water in pail. If possible the water should be 50° F. or colder.

Make the examination and notes, and change the water every twelve hours until both lots of milk are noticeably sour. If the work has been properly done there should be from half a day to a day and a half difference in the keeping quality of the two lots of milk.

The Ohio State Agricultural College is issuing a series of extension bulletins containing numerous suggestions for simple agricultural experiments, such as the following:

EXPERIMENT NO. 9.

Take a small piece of butter in a teaspoon. Heat it with a lighted match. It froths freely but quietly. Try the same experiment with a piece of oleo, if it is available. It does not froth but melts down like grease and cracks and sputters. Renovated butter will do the same. Milk fat is a mixture of a number of fats, some of which are volatilized (turned into vapor) at comparatively low temperature (by the heat of the match) and makes the butter froth. Oleo does not contain these fats. Notice the difference in the odor of the melted butter and oleo. Renovated butter is a rancid butter which has been made over by a process of heating and rechurning. The volatile fats have been driven off by the heating.

EXPERIMENT NO. 10.

Fill a large flower pot with loam which has been thoroughly dried. Weigh the pot and loam with a spring balance (see that it will show ounces, for the weighing must be done accurately). Pour in water very slowly until it runs from the hole in the bottom of the pot. Wait until the water has ceased running. Weigh again and determine the per cent of water the loam would hold. It would be well to know what the flower pot weighed before putting the loam in it.

Try the same experiment with dry clay or with sand

The water you see running away corresponds to the water that should be taken away from soils by tile drains.

The Northwest Journal of Education for November, 1905, contains an article by Prof. George Severance, of Washington State College, on Teaching Agriculture in the Common Schools, in which a series of nine interesting exercises concerning the amount of water held in field soils under different conditions of culture is given. This is a matter of primary importance in regions of limited rainfall, and we therefore quote three of the exercises:

Exercise 1.

Object.—To compare the amount of water held at different depths under stiff sod or hard stubble land and under loose well tilled surface.

With soil auger and six bottles or tight covered cans, go to the fields and select some place where sod land adjoins a summer fallow or land that has been kept well tilled for the summer and select a spot in each where the slope and exposure are practically the same. Avoid proximity to trees or brush or any disturbing factor. With the auger secure a separate sample of the first, second, and third foot in each place, being careful to transfer the soil to the bottles as quickly as possible, covering the bottles or cans tight to avoid loss of moisture by evaporation.

At the schoolhouse weigh out a portion of each sample and dry for twenty-four hours over a stove, in an oven, or even over a lamp. When thoroughly dry reweigh. The weight lost in drying divided by the weight of dry soil will be the per cent of moisture held. Keep accurate records of results. In taking the moist soils from the cans and getting the first weight see that it is done quickly to avoid loss of moisture by evaporation.

This same comparison may be made on level land and on sloping land. If the fall rains have not percolated downward 3 feet when the first samples are taken note the depth to which it has percolated in each. What condition shows the deepest percolation? Is it an advantage? Which condition shows the most total water for the 3 feet? Which the least? What has become of the rest of the water?

Exercise 2.

Object.—To compare fall plowed land with similar land left until spring, following directions as in Exercise 1, the teacher and the pupils should note by observation which conditions seem to permit the most water to run off the surface. In many sections of our State this comparison will show quite markedly the advantage of fall plowing in helping to catch and store the moisture. If both the fall plowed and the spring plowed land are seeded in the spring to the same crop, as often happens, watch the crop carefully for differences. Observations at Pullman have shown marked results in favor of fall plowing. Should the fall plowed land be harrowed smooth or left rough in the fall? If the land is rolling does it matter in which direction the plowing is done? Do bad results ever come from fall plowing?

Exercise 7.

If opportunity occurs, compare land that is rolled smooth in the spring and left so with adjoining land similarly cropped but not rolled. Contrary to the belief of many, a rolled surface gives the best conditions for loss of moisture.

A word of caution regarding the experiments and exercises will perhaps be in order at this point. See that the pupils use the utmost care in the manipulation of materials and apparatus, so that results as nearly accurate as possible may be secured.

Do not tolerate carelessness even with the simplest exercise and the most inexpensive material. Not that the exercise will have any particular bearing on the progress of science, but it ought to have a very definite bearing on the development of the pupil. It should aid in developing not only skill in manipulating materials and apparatus but accurate habits of thinking—critical discernment, careful comparison, and accurate judgment.

Advantage should be taken of every opportunity to connect the agricultural work in school with the home life of the pupils, not only by means of visits to farms as suggested above, but also by having the pupils carry on at home simple experiments with varieties of crops, and with milk, poultry, bees, farm animals—whatever seems to appeal to them most. Secure the active cooperation of the parents so that all the facilities of the district may be made available for the education of their children.

Keep in mind all the time that the amount of information which the pupil gets from this study is of comparatively little importance. This elementary course in agriculture will have failed of its main purpose unless it shall have opened the mind of the child to the possibilities o profitable and pleasing study of the products and operations of the farm, shown him the practical value of a knowledge of underlying principles, created in him a belief that farm practice and profit may be improved by intelligent utilization of the results of scientific research, stimulated a desire for investigation and invention on his own part, and inspired in him a love for country life and pursuits.

TEXT-BOOKS AND WORKS OF REFERENCE.

There are about a dozen elementary text-books which cover the subject of agriculture in a general way, and numerous text-books on special phases of agriculture, manuals, encyclopedias, bulletins, and leaflets which would be valuable to both teachers and pupils if placed in rural school libraries. In this article only a few of these publications can be mentioned.

The United States Department of Agriculture has issued many publications which are proving valuable to both teacher and pupils engaged in school agriculture. The Farmers' Bulletins of the Department are for free distribution, and several of them were prepared especially for use in schools. Farmers' Bulletin No. 157, The Propagation of Plants, deals in a simple and practical way with methods of reproducing plants, such as layering, grafting, budding, and making cuttings. Much of this matter is reproduced in Farmers' Bulletin No. 218, The School Garden, which also takes up practical suggestions for garden work, describes a series of laboratory exercises with soils and plants, and discusses the decoration of school

grounds. One of the writers prepared an article for the 1905 Yearbook of this Department on The Use of Illustrative Material in Teaching Agriculture in Rural Schools, and the same author prepared Bulletin 186 of the Office of Experiment Stations on Exercises in Elementary Agriculture.

Teachers of agriculture in common schools should write to their State colleges of agriculture and experiment stations and to the Office of Experiment Stations of the United States Department of Agriculture for bulletins and other aids. Much valuable literature can thus be had for the asking which has been prepared by experts in the different branches of agriculture.

General text-books of elementary agriculture.

Bessey, C. E., et al. New Elementary Agriculture (Lincoln, Nebr.: The University Publishing Co., 1903, pp. x+194, figs. 62).

Burkett, C. W., et al. Agriculture for Beginners, [with Special Horticultural Supplement, 1904] (London and Boston: Ginn & Co., 1903, pp. xi+267, figs. 215 and frontispiece). Numerous suggestions for experiments are given.

Goff and Mayne. First Principles of Agriculture (New York, Cincinnati, Chicago: American Book Co., 1904, pp. 248, colored pls. 8, figs. 135).

Goodrich, C. L. The First Book of Farming [Plant Production] (New York: Doubleday, Page & Co., 1905, pp. xx+259, figs. 86).

Hatch and Haselwood. Elementary Agriculture with Practical Arithmetic (Chicago: R. K. Row & Co., 1906, pp. 207, pl. 1, figs. 47). This is a text-book of agriculture suitable for use in elementary rural schools. It treats in a brief but logical way of plant and animal production and devotes some space to farm mechanics and economics. The feature which distinguishes this book from any other that has appeared in this country is the nature of the practicums, which consist of problems in agricultural arithmetic. There is a total of 274 of these problems, of which there are from 6 to 24 following each chapter and related to the subjects discussed in that chapter.

Jackson and Daugherty. Agriculture through the Laboratory and School Garden (New York: Orange Judd Co., 1905, pp. 403, pl. 1, figs. 150). Suggestions for experiments in laboratory exercises and field work are liberally interspersed throughout the book, and nearly every chapter is followed by references to literature related to the subject under consideration. There are also appended lists of general references to publications, lists of agricultural experiment stations in the United States, and of publishing houses whose books are mentioned in the reference lists, and a glossary.

Books and bulletins for reference.

GENERAL.

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THE FARMERS' INSTITUTES IN THE UNITED STATES, 1906.

By John Hamilton,

Farmers' Institute Specialist, Office of Experiment Stations.

The condition of the farmers' institute work of this country for the year ended June 30, 1906, as indicated by the reports sent in by the State directors, is quite gratifying. All of the States and Territories excepting Alaska now have institute organizations and all except Florida, Nevada, New Mexico, and Washington held institutes during the year.

The failure of these States to hold institutes was due to their respective legislatures having neglected to make necessary appropriations for their expenses. This interruption in their institute work is doubtless only temporary, since in most of the instances there does not seem to have been any serious dissatisfaction on the part of country people with the character or conduct of the institutes. The failure of the appropriations appears to have been due to conditions not likely to recur.

INSTITUTE STATISTICS AND PROGRESS.

The 45 States and Territories reporting show an aggregate of 11,409 sessions of regular institutes held during the year, with a total attendance of 1,299,172 persons. The attendance is computed by counting all present at each session and then adding these together for the total. This method is open to the criticism that it is inaccurate, since the same persons may be counted twice, or even several times. While this is true, the method nevertheless enables the actual condition of the work to be more nearly ascertained than the old method of taking the attendance at the largest session and adding to it one-half of those present at the next largest for a total. Institutes of only one or two sessions under the old method of computation often had the same attendance to their credit as those composed of five or six sessions—a manifest untruth and injustice.

By comparing the number of sessions held in 1906 with those held the previous year there is shown an increase of 854 sessions in favor of 1906, and by dividing the number in attendance in 1906 by the number of sessions held there is shown an average attendance at each session of 114 persons, as against 94 in 1905.

There was a corresponding increase in the number of lecturers employed by the State directors upon the regular corps of instructors. The number of lecturers in 1905 was 995; in 1906 this had reached 1,225, an increase of 230.

The money available for institutes in 1906 was considerably more than for the previous year. The amount available in 41 States in 1905 was $225,738.89, and in 1906 in 45 States $269,672.38, an increase of $43,933.49. By comparing only States that have carried on institutes during both years there is shown an increase of $35,072.90 in those States in 1906 over 1905, or a little more than 15 per cent.

For several years there has been a decided and steady advance in the amount contributed for institute support outside of the State appropriations. In 1903 the amount from this source was $9,345; in 1904 it increased to $11,394.91; in 1905 it was $20,556.76, and in 1906 it was $42,550.39, or 455 per cent more than the amount contributed in 1903.

This general increase in the appropriations for institutes has enabled the institute directors to improve their work by securing better teachers on the instruction force, but at the same time this improvement has slightly increased the average cost of the institutes per session. The average cost per session in 1903 was $23.32. In 1906 it was $28.12, an increase of $4.80. The attendance at the special institutes reported by 19 States numbered 85,762. Fifteen States reported round-up meetings with an attendance of about 24,598. In 21 States railroad specials equipped with agricultural experts were sent out. In some of these States these specials were run under the auspices of the farmers' institutes, while in others they were independent of the institutes and consequently were not reported by the institute directors. Reports, however, were received from the following 13 States, giving the approximate attendance upon the institute special trains: Connecticut, 2,500; Illinois, 54,450; Kansas, 10,000; Maine, 55,000; Maryland, 3,125; Massachusetts, 6,000; Michigan, 5,000; Minnesota, 900; Mississippi, 9,127; Nebraska, 34,092; North Dakota, 17,696; Vermont, 10,000; Virginia, 8,000—making a total of 215,890. The aggregate attendance for the year at the regular institutes, the round-up meetings, the special institutes, and the railroad specials amounted to 1,625,422, about twice the number reported in attendance for the year 1903–4.

The teaching force of the State institute directors has enlarged from 924 expert lecturers in 1903 to 1,225 in 1906. The number of lecturers supplied by the agricultural colleges and experiment stations has increased from 196 in 1903 to 342 in 1906, and the time contributed in the same period by these lecturers in reported to have increased from 1,666 days to 3,119.

These facts are unmistakable evidences of progress, showing that the institutes have not only gained in wide recognition and in public confidence and appreciation, but that they are also reaching with agricultural truth a great body of workers, most of whom, but for this agency, would have been unable to have secured the information which they give for themselves. In this connection it is also worthy of note that the States in which the institutes have been longest in operation have begun to enlarge the scope of their work to include other forms of education extension, as boys' and girls' clubs, women's domestic science associations, and normal school work.

SUPPLYING COMPETENT LECTURERS.

Several State directors report that they have organized and conducted during the year schools of instruction for their institute workers. The need for training schools for preparing lecturers for their work is becoming generally felt. Out of twenty-three replies to the query "In what respects do you need assistance in your work?" nineteen asked for competent lecturers. The regular work of the agricultural colleges and experiment stations has increased to such a degree that in most States they find it no longer possible to spare their experts for any considerable amount of institute teaching; consequently, the directors of institutes are being compelled to face the question of preparing teachers for their institute work. This is particularly the case in the larger and more densely populated States.

Three methods for meeting this need are being considered. One is the establishment of interstate normal schools of agriculture, thoroughly equipped for giving the kind of instruction demanded, and open to institute workers at nominal cost. Another is the employment of fewer men as expert teachers and keeping them employed for a longer period. The movable school of agriculture is an effort in this direction. The third is a normal course in each agricultural college to fit men for institute teaching. The final solution of the difficulty will probably be found, not in the adoption of any one of these methods, but in a combination of all.

The demand, at least in the older States, is for high-grade instruction. The agricultural colleges and experiment stations in these States have set the standard until now in many localities anything below the best in institute teaching is received with impatience, and if persistently offered is openly rejected. It has been apparent to all thoughtful institute directors and teachers for some time that some modification of the institute system must be made if it is to be adapted to the new conditions and meet the increasing demands that have arisen in agricultural education.

THE REORGANIZATION OF THE INSTITUTE.

The somewhat sensational and elementary period of the farmers institute movement is about over. The problem now is, What shall be substituted in their stead and what form shall the organization take in order to most effectively carry on its work?

This raises the whole question of the field and functions of the farmers' institute. The institute movement has reached a point where it is important to have its purpose and scope clearly defined. What ought the institute to embrace? What ought it to be?

Although the institute movement has been in active operation for over twenty-five years, no satisfactory definition respecting the field that it should occupy, the precise methods to be adopted in imparting instruction, or the form of organization best for accomplishing its purposes have yet been agreed upon.

During the early period of the institute movement, which consisted largely in arousing the public and creating sentiment in favor of agricultural education, good work was accomplished without any, or at least with very little, system. Now that the work has been well started its scope extended, and gives evidence of permanency as an educational institution, a carefully considered definition of purpose has become a necessity, as well as the adoption of some well-organized plan for carrying it out. Two important committees have been at work during the past year investigating this question. One is a standing committee of the American Association of Farmers' Institute Workers on "cooperation with other educational agencies," and the other is a standing committee of the Association of American Agricultural Colleges and Experiment Stations on "extension work." These committees made reports to their respective associations this year. Their investigations were largely confined to securing data showing what is now being done in agricultural extension work and in discovering the institutions engaged in conducting it. For the coming year the committees propose to consider the subjects in greater detail, and have arranged to conduct so much of their investigation work as is common to both in cooperation.

There is prospect, therefore, that in the near future, through the instrumentality of these agencies and others now at work, the agricultural education extension movement in its various phases will be consolidated into a single organization constituted on lines broad enough and strong enough, both financially and educationally, to most efficiently carry out the great purpose of its existence—the improvement of country living, intellectually, socially, morally, and financially.

The great interest that the agricultural colleges and experiment stations are manifesting in respect to the work and organization of

the farmers' institute, while partly due to the relations that have existed in the past, whereby much of the instruction given in the institutes has been by the teaching force of these institutions, is no doubt mainly because in thirty States and Territories the institute control is entirely in the hands of the colleges and stations, and in three others it is about equally divided between them and the State departments of agriculture. The question of the future field and efficiency of the institute, therefore, affects directly the usefulness of these colleges and stations as leaders in agricultural education and the institute work for which they are responsible can not, therefore, be permitted to remain much longer in its present undefined and unorganized condition.

MOVABLE SCHOOLS OF AGRICULTURE.

Much of the time of the institute specialist during the year has been devoted to perfecting plans for the organization of the movable schools of agriculture referred to in the last report. A bulletin entitled a Course in Cheese-Making for Movable Schools of Agriculture has been issued. The course consists of 14 lectures, with references and a corresponding number of practice exercises.

Great care was taken in the preparation of this course to have it in proper pedagogic form. The difficulty of condensing the subject into comparatively few lectures and at the same time insure its reasonably full treatment was partially overcome by the liberal use of references by the lecturer to authorities, indicating the volume and page where extended descriptions may be found.

Immediately following the lecture and preceding each practice exercise a period of several hours is expected to be given to looking up authorities and to collateral reading. No notes are to be taken during the delivery of the lecture, but at its close a syllabus with all of the references will be handed to each student. In this way the undivided attention of the members of the class can be given to the substance of the subject treated without their being compelled to devote their time to the mere manual operation of transcribing.

The practice exercises are upon the points presented in the lecture, and vary in length from one to four hours, according to the nature of the subject. A complete list of apparatus needed and of books of reference is given in the bulletin, thus enabling the character and cost of equipment to be ascertained and provided for. The complete outfit of apparatus for 15 students, including the library of reference, need not exceed in cost four to five hundred dollars.

A course in fruit growing is now in press, and other courses are being prepared.

RAILROAD SPECIALS AND INDUSTRIAL WORK OF RAILROADS.

Railroad specials equipped with lecturers, charts, specimens, books, bulletins, and demonstration material have been sent out in 21 States. This movement in institute work, begun in the Western States three or four years ago as corn specials, has extended to the East and South, and they now give instruction upon a wide range of topics adapted to the agricultural conditions of the several sections. The institute specialist accompanied one of these trains last spring through a portion of Illinois. The train was furnished by the Illinois Central Railroad Company, and consisted of a locomotive, baggage car, two coaches, one dining car, and a compartment sleeper. The company bore all of the expenses excepting the salaries of the lecturers, which were met by the University of Illinois. Although the country roads were deep with mud, the attendance at the stations at which the stops were made was all that could have have been desired, ranging in number from 150 to 400. One day by actual count the attendance was over 3,500.

Reports of similar manifestations of interest have come from other States in which these trains have been utilized. The novelty of the method has no doubt had something to do with the attendance, but there seems also to have been, as evidenced by the close attention given to the lecturers and by the questions asked, a real desire for information.

Perhaps the most significant feature of this movement is the interest that the transportation companies are taking in agricultural education, or at least in the dissemination of agricultural information. In every instance prominent railroad officials have accompanied the trains, and have assured the farmers of their interest in promoting the welfare of farming people. This effort on the part of the railroads to improve agriculture is undoubtedly the beginning of the organization in the management of these companies of a corps of agricultural experts who shall devote their entire attention to the development of agriculture in its several phases, and also to assisting farmers in the marketing of their crops.

A recent investigation by the institute specialist into what the railroad companies of the United States are doing in aid of agriculture discloses the fact that with few exceptions they are coming as never before to appreciate this source of traffic, and quite a number of companies have already begun the organization of departments for the aid and encouragement of this industry. One company has three expert specialists and two assistants who devote their entire time to instructing and otherwise aiding the farmers. This company also publishes a monthly magazine giving information with respect to farm lands and methods of culture. Another company has been

instrumental in organizing fruit growers and truckers' associations at different points along its road, and issues printed circulars and bulletins of information respecting the agricultural advantages of the several localities through which the road passes. This company also employs experts to teach the trucker and farmer, and to oversee and assist him in his work. Some of these experts have had training in the agricultural colleges and experiment stations of the country, and others are commercial men of years of experience, who aid in marketing produce and assist by teaching the fruit growers and truckers how to grade, pack, and prepare their products so as to suit the peculiar demands of the various cities. This road has a soliciting freight agent in every northern city of any magnitude. The agent informs the fruit growers' associations and individual growers daily, and oftener if required, as to the exact condition of the market in the city where he is located. He advises of the arrival of the cars, the condition of the contents, and often gives the prices which were obtained for the consignment before the consignee reports the arrival of the car.

Another company has distributed along its lines 800 pure-bred bulls and 6,000 pure-bred pigs for breeding purposes, and it also offers prizes for the best-managed farms in the several districts through which it runs.

A western company has organized thirty-five farmers' institutes and truck-growers' associations. Another reports eighteen such organizations in its territory. In Texas the railroads have associated for the development of the industries of the State, and are encouraging and aiding the introduction of diversified crops, the improvement of the rural schools, and the construction of substantial highways in the country districts. The industrial agent of an important road in the Southwest, in reporting upon the methods adopted by that road in the encouragement of agriculture, states, "I have tried to use methods in promoting the success of the various farmers along our line in diversified farming the same as if they were tenants on a big plantation and I its manager responsible for their success."

There is opportunity for this Department to assist the railroad companies, and through them the agricultural industry, by investigating the relation of transportation to agriculture, and advising as to methods that the companies can adopt that will assist farmers in the marketing of their crops, and encourage the production of such articles as are best suited to their soils.

NEW FEATURES.

A number of new features have been introduced into the institute work during the year which give promise of becoming valuable additions to the methods heretofore used in giving instruction. In one

county of Illinois (Scott) the Business Managers' Association of Winchester offered a prize to one boy in each voting precinct ($10) toward defraying his expenses at the winter short course at the State Agricultural College. The method adopted in selecting the boy from each precinct was to distribute a 14-page bulletin on Soil Fertility among the young people in the public schools of the county. The pupils were requested to study the bulletin and report at the next meeting of the farmers' institute for examination, the one standing highest in each voting precinct to receive the prize.

This year fifteen boys appeared for examination, representing nine voting precincts. As a consequence, nine voting precincts in that county will be represented in the college of agriculture in the State University this year. This experiment, fairly successful in its first trial, suggests wide possibilities, extending in many other directions, in interesting young people in agricultural education.

Another experiment, conducted in Carroll County, Md., under the direction of the farmers' institute, was the employment of a peripatetic teacher of agriculture to visit the country schools and speak to the scholars on country life, particularly in its agricultural features.

While the experiment was not as successful as its promoter wished, owing to local conditions which were unfavorable, it nevertheless is a feature of extension work that is entirely feasible, since substantially the same methods have been in use in European countries for many years, and everywhere with pronounced success.

Another plan for securing a closer union between the institute and the public schools was put in operation in Michigan with some degree of success. Several county secretaries of farmers' institutes made arrangements with the county superintendents of schools by which the superintendents furnished speakers for a series of institutes to continue from four to twelve days. During the forenoon of the day upon which the institute was to be held the county superintendent of schools, accompanied by the speaker which he furnished, visited the schools in the neighborhood where the meeting was to be held in the afternoon. Brief addresses were made to the pupils, and then the teachers were requested to dismiss their schools, so that the older pupils could attend the institutes in the afternoon and evening. At the afternoon and evening sessions of the institute the regular speakers employed by the institute director delivered addresses on agricultural subjects, and then the speaker furnished by the superintendent of schools, frequently the superintendent himself taking part, addressed the institute upon topics relating to rural schools and country life.

In California cooperation between the institutes and the public schools is formal and organized. A farmers' institute section has been created in the State Teachers' Annual Convention. This section

heretofore has been chiefly for the purpose of the discussion of methods for the introduction of agriculture into the public schools. This year similar farmers' institute sections are to be formed in the several district teachers' associations as well.

The superintendent of farmers' institutes for Saskatchewan, Canada, has introduced a feature into his institutes that has been quite popular and successful. In the stock-growing sections he has converted the morning and afternoon sessions of the farmers' institute into stock-judging schools, holding the regular institute meetings at night.

A number of State directors of institutes have been holding field meetings successfully, examining crops, spraying fruit, inspecting fields, gardens, farmyards, stables, etc.; examining animals and crops, and identifying fungus diseases and injurious insects.

In one other State special sessions of institutes have been held, one or two each month, and in another the main addresses have been materially shortened, the major portion of the time being devoted to discussion.

In the Province of Quebec, Canada, the director has undertaken to classify the subjects that the institutes are to treat into groups, and the lecture force is selected with a view to meeting the special requirements of each group. It is stated that this classification has assisted in organizing the work in a more methodical way and has enabled the director to control the teaching force in such a way as to meet more satisfactorily the special needs of different localities. The grouping at present is under the following general heads: (1) Feeding the milk cow; (2) the breeding of the bacon pig; (3) agricultural instruction in rural schools; (4) fodder plants and herbs; (5) cultivation of the soil; (6) improvement of live stock; (7) bee culture on the farm; (8) poultry rearing; (9) fruits and fruit trees, and (10) gardening.

Each of these topics is subdivided into a number of items, as, for instance, topic No. 5, on the cultivation of the soil. This is treated under five divisions or subtopics: (a) Rotation; (b) tilling the soil; (c) drainage; (d) farmyard manures and commercial fertilizers, and (e) green manure.

This is an attempt to define in a practical way the scope of the institute, and if developed will result in a clearer understanding of what the institute is organized to do and the precise methods which it proposes to use in carrying out its purpose.

Two new features have developed during the year in connection with the institute trains or railway specials. The method in most of the States heretofore has been to endeavor to cover as much ground in a given period as possible. As a consequence the stops at the several points have necessarily been quite brief, limited to from thirty to forty minutes. One State, this year, has departed from

this and scheduled each of its stops for two hours. This has given more time to confer with those who attend the meetings to deliver lectures and to give explanations. The other method was the utilization of the institute railway special as an "emergency train" designed to cover as large a territory as possible in a brief period. This was for the purpose of disseminating a single item of information of special importance which the farming people needed to know immediately, in order that they may successfully meet the new conditions which the emergency has brought about. The train is delayed in its sending out until just before the farmers are ready to perform the operation which it is desired to influence. In North Dakota, for instance, this took the form of a "wheat rust special" sent out immediately before the wheat-seeding period. The lecturers showed the rust in its forms of attack and gave remedies and methods of treatment of the seed, teaching the farmers how to treat it themselves and urging them to adopt the methods recommended. The timeliness of the information made it more impressive than if attention had been called to the matter months before. Many farmers treated their seed according to the directions who would not have done so had it not been for the somewhat sensational method, and more than all the well-timed period of calling attention to its importance.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

The eleventh annual meeting of the American Association of Farmers' Institute Workers was held at Baton Rouge, La., November 12–14, 1906. Thirty-seven States and Territories were represented and 4 of the provinces of Canada, with a total attendance of 116. Statistical reports showing the condition and progress of the work were presented by 34 States and Territories and 5 provinces.

The association, at its meeting in Washington, provided for the appointment of standing committees on institute organization and methods, institute lecturers, cooperation with other educational agencies, movable schools of agriculture, boys' and girls' institutes, women's institutes, and legislation. The reports of these committees constituted a most important feature of the Baton Rouge meeting. The committees had given a good deal of careful thought to the subjects assigned them, and their reports, consequently, contained many well-considered suggestions. The great importance of the thorough organization of the institute was dwelt upon with much emphasis and particularity. The president, in his annual address, referring to this feature of institute work, said:

> I am thoroughly convinced that the crying need is for stronger organization among farmers themselves, calling for regular meetings every month or oftener in each locality, conducted and managed entirely by local help, with an occasional outsider who

knows the needs of the district. This state of things, in my opinion, can best be brought about by a permanent organization in each county, with committeemen or directors in every farming community. The secretaries of such local institutes soon become regular correspondents of the State directors. All communications are sure to come before the local board at the regular meetings, the localities themselves designating where the meetings are to be held, and hold themselves responsible for their success or failure.

He continued:

Such an organization, wherever tried, has brought about the following results: (1) More and better meetings in each county; (2) feeling of responsibility for the success of the meetings, because they are "ours;" (3) a closer touch with the State department of agriculture; (4) thorough organization, an opportunity of visiting and studying the methods of work employed by the State agricultural colleges and experiment stations, and (5) by virtue of the increased number and regularity of the meetings an opportunity is given and appreciated of carrying out a systematic study and discussion of the principles underlying the science and practice of agriculture.

The president concluded this part of the discussion by saying:

I feel that I can not speak too strongly on the absolute necessity of organized effort in this educational movement if we are to raise the general standard of intelligence among farming people.

The standing committee on institute organization and methods in their report agree that the organization of the institute has now become a necessity in order to do effective work. The report says:

It appears to your committee that so far as possible there should not only be a State organization to lay out and supervise the work, but that there should also be county, township, and similar local organizations, to have immediate charge of the arrangements for the meetings, and that these should be of a permanent nature, with a constitution, by-laws, and rules for carrying out their institute work. The maintenance of local organizations with regular members, each of whom pays a small fee, also serves to increase the interest in the work, particularly if they can be made to feel that it is "their institute." And, on the other hand, while the local officers would be consulted regarding topics, dates, and places, the actual selection and assignment of speakers, the grouping of meetings, which to a certain extent will fix the time and place for the meetings, should remain with the State director or superintendent of institutes. To this end we again commend the general scheme for an institute system prepared by our secretary, Mr. Hamilton, and which was printed in the last report of the association.[a]

The report of the committee on women's institutes was in the nature of a preliminary report, giving only the localities in which such institutes are found and the condition of women's institutes in the United States and Canada. Replies in answer to inquiries by the committee respecting the condition of the women's institute work were read from 33 States and Territories and from 5 of the provinces of Canada. Twenty-two States and 3 of the provinces reporting had no separate organizations for women, although many women attended the regular institutes. In 11 States and 2 provinces women's institutes have been organized with satisfactory results. The committee

[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 165, p. 78.

did not offer any formal recommendation for adoption by the association, but submitted the results of their investigations as a report of progress.

The committee on institute lecturers directed its efforts chiefly to discovering whether or not there is an adequate supply of capable institute lecturers available for the work. In beginning this investigation the committee were confronted with the need for a definition of institute work, its purposes, and scope. The committee say:

The purposes and scope of the farmers' institute work must be determined and established before intelligent recommendations can be made regarding ways and means of supplying suitable institute lecturers. This must be determined before we can even know what sort of institute lecturers we need, much less formulate and execute plans for securing and maintaining them.

The committee then announced their views in the following language:

In the opinion of this committee the work of the farmers' institute is educational; to carry agricultural education to those on the farms who have lived beyond the usual school or college age. Farmers' institute work is in no sense university extension any more than is an agricultural college a university. The investigations of the committee convince them that in most States there is no scarcity of institute lecturers capable of entertaining an audience; but that there is a lack of fit instructors in agriculture in many of the States, and the reason why other States reported "that there was no scarcity" was because there was little demand—that is, "little work was being done."

The committee, in considering the preparation of a sufficient supply of efficient lecturers, expressed the following view:

The suggestions of your secretary for district (interstate) schools for the training of institute workers seems to be best. Two, three, or more States, where conditions are similar, are combined to educate institute workers and interchange in their employment. This would be the cheapest and most effective method. In the way of this and of all other methods, however, stand two difficulties—short periods of service and low compensation.

The conviction expressed by the committee, that in the way of securing permanently an effective force of institute lecturers, stand the two difficulties, that of short service and low compensation, states a most important truth. In some way the farmers' institute will have to provide a career for its teachers similar to that of educational institutions having fixed classes, and the compensation must be sufficient to attract the most competent teachers to this service if it is to maintain itself at an educational standard above mediocrity.

In the discussion it was suggested that it might be possible to establish normal departments in the agricultural colleges for the training of institute lecturers, requiring the student to deliver lectures and undergo criticism and questioning by his audience, after the manner of a real institute meeting, admitting to this class graduates of the institution and others whose educational qualifications

were of proper standard. The committee did not present any formal recommendations for adoption, but offered its suggestions for discussion and further consideration.

The committee on cooperation with other educational agencies presented a quite extended report. Their investigations were mainly directed to securing information upon four points: (1) Cooperation with the National Department of Agriculture; (2) cooperation with the State experiment stations; (3) cooperation with the superintendents and teachers of schools. and (4) cooperation with the agricultural colleges.

A large number of inquiries were sent out requesting information and many replies were received. As a result of their inquiry and of a careful study of the question by the individual members, the committee presented its conclusions in the form of a number of statements, concluding with the following resolutions, which the association adopted:

That it is the sense of this association that an important function of the farmers' institute is one of cooperation with other educational agencies; that the institutes should, whenever possible, be so managed as to bring together a goodly number of those engaged in agricultural practice; that there should always be some instruction that is in accord with the work of the experiment station and the United States Department of Agriculture; that this instruction should be so presented as to awaken interest in what is being done in agricultural investigation, and turn the attention of the people to the sources of information; that the young people and their teachers should be interested to attend the institutes, and the programmes should be so arranged that their interest in agricultural education may be awakened and the cooperation of the schools secured. In a word, it is the sense of this body that the aim of the institute should be (1) to teach a few things, and (2) to do this so well that the desire to know many things will be created; (3) to point the way to the sources of information—for adults, the station and the Department of Agriculture; for young people, the schools and agricultural colleges, and (4) to make sentiment in favor of a liberal support of all these educational agencies.

The committee in analyzing its correspondence found that in answer to the query, "To what extent is such cooperation desirable?" 41 out of 53 replied, "To the fullest extent practicable;" and to the question "To what extent has such cooperation been practiced in your State?" 44 out of 53 replied, "To the fullest extent practicable." The investigation revealed the fact that there is both on the part of the institutes and on that of the other educational agencies a most cordial spirit of cooperation.

The committee on movable schools of agriculture directed attention to the need existing for giving a greater amount of special instruction in the institutes than has been given in the past, and that the future development of the institute would be along these lines. They suggested that the movable school, teaching thoroughly a few fundamental agricultural subjects according to a well-constructed course of study, offers a possible solution of the present

difficulty. The committee recommended and the association passed the following resolutions expressive of the sense of the members upon this subject:

Resolved, That this association, appreciating the importance of providing more systematic and extensive instruction in agriculture in the farmers' institutes, hereby expresses its approval of the use of the movable school of agriculture as an instrument for this purpose. Second, that it commends the form of organization outlined and courses of study prepared by the National Department of Agriculture for the establishing of such schools, and hereby earnestly requests the Committee of Agriculture in Congress to recommend and the Congress to pass an appropriation sufficient to enable the Department to perfect plans and courses of study and to organize, equip, and place in operation, in charge of competent experts, a number of these schools as demonstrations of their value and practicability.

The committee on boys' and girls' institutes addressed six queries to the State directors of institutes respecting the number of boys' and girls' institutes held in their several States, their special features, the attendance and interest, the character of programme best adapted to these meetings, and the kind of publications most helpful in interesting farmers' boys and girls in agricultural subjects.

The committee concluded its report by saying—

That there is certainly very great interest in the subject of boys' and girls' institutes is indicated by this correspondence. This interest may be viewed as part of the general movement for more extensive instruction in agriculture among rural young people, which has manifested itself in recent years not only by greatly swelling the attendance in the agricultural courses in our agricultural colleges, but also by introducing instruction in agriculture into the rural schools.

There are various agencies at work along these lines. In some States there seems to be no need for the farmers' institute taking it up; in others, the farmers' institute appears to be about the only organization through which we can hope that the possibilities and advantages of agricultural education can be brought to the attention of the American people.

The proceedings of the convention published for distribution by this Department are accessible to those who are interested in the details of its deliberations.

EDUCATION EXTENSION IN AGRICULTURE.

In addition to rendering assistance to the farmers' institutes, the duties of the institute specialist were enlarged during the year to include investigations into the other forms of agricultural education extension work. In these investigations the Department is cooperating with the standing committee of the Association of American Agricultural Colleges and Experiment Stations on extension work of which the institute specialist was made secretary.[a]

In conducting this cooperative investigation the secretary sent out about 5,000 circular letters to educational institutions and to social

[a] For report of the committee see U. S. Dept. Agr., Office of Experiment Stations Cir. 72.

and business organizations requesting information respecting such forms of agricultural education extension as they might be conducting. Each letter was accompanied by a blank upon which to make out the report and by a franked envelope for transmitting it to the Department. One thousand and one replies were received and 317 of them, or about 6 per cent of the entire number addressed, were engaged in some form of extension work.

The investigation showed not only that there is deep interest on the part of educators everywhere in the agricultural education extension movement, but that there is also a large amount of work of this character now being carried on throughout the country. While no single institution has engaged in all of the lines of agricultural extension activity, yet in the aggregate almost every feature of the agricultural industry is recognized by some educational effort in its behalf.

The correspondence brought into prominence several important facts. The first is, that there is among educators in the higher institutions of learning in all of the States a sincere and deep interest in the success of the movement for imparting agricultural information to the masses. This is particularly true as respects those who are connected with the agricultural colleges of the country. While the amount of extension work which they are doing is considerable, the methods employed are as yet diverse and ill-defined. There has been no agreement among their faculties respecting methods for carrying on extension work, the subjects most needed to be taught or the pedagogic form that the instruction should assume.

Another important fact was developed. It is the universal appreciation by country people of what has been attempted in agricultural education in their behalf. Whether the effort has taken the form of the farmers' institute, the traveling library, school garden and field demonstration work, nature study, agriculture in the public schools, the corn-judging contest, stock judging at county fairs, agricultural literature, courses of lectures by college men on agricultural subjects, the railroad special, the dairy expert—all are thoroughly appreciated. Instead of the information thus given satisfying the farmers' desires, the demand is for more and for further systematizing, perfecting, and extending these lines of effort until the information which is now only fragmentary and disconnected will be systematized so as to become a proper and permanent part of the general system of industrial education.

A third fact expressed in the communications is the desire on the part of those who are engaged in this extension movement for plans and methods that will enable them to do more effective work along extension lines. Each worker until now has been dependent largely

upon himself for plans and methods and has been living in comparative ignorance of what his fellow-workers in agricultural education are doing in similar directions. The mere collecting and publishing of what is being attempted in agricultural extension work will, no doubt, by the mere bringing together of suggestions and placing them in the hands of educators, gradually secure their adoption and thus in time effect substantial unity of method.

Another feature which the investigation revealed is the increased use of agricultural literature wherever agriculture is being taught to country people. Standard agricultural books, experiment station bulletins, publications by the United States Department of Agriculture, and agricultural periodicals, all are taken and read as never before. Children in their school and home garden and in their corn-growing contest work are reading scientific books and bulletins to get the latest information to enable them to plant, fertilize, cultivate, and care for the things that they have undertaken to produce.

A fifth fact is the intense interest that school children are taking in agricultural study both in the town and country schools. The reports without exception, when speaking of this phase of education work, refer to it as a point of special note.

The investigation further shows that a great obstacle in the way of extension work in agriculture is the lack of teachers qualified for giving this kind of instruction. The means for supplying an adequate number of capable teachers is a problem not yet satisfactorily solved. It is manifest, however, that this extension work in agriculture must, before competent teachers can be had, provide a profitable career for educated men. Extension teaching will have to become a profession to be engaged in continuously and be at least as remunerative as regular instruction service in colleges or normal schools, before competent men and women will prepare for and enter upon institute work as a life pursuit.

The committee in its report formulated the following tentative definition of extension teaching in agriculture:

> Extension teaching in agriculture embraces those forms of instruction in subjects having to do with improved methods of agricultural production and with the general welfare of the rural population that are offered to people not enrolled as resident pupils in educational institutions.

The institutions for higher education not agricultural are doing very little in the way of extension teaching in agriculture. The normal schools, however, have taken up this work with considerable vigor in some of the States and have not only been giving agricultural instruction to their students but have also been sending out instructors to assist in the farmers' institutes, by delivering lectures, to conduct demonstrations, and to aid in school garden work, in connection with the district schools. Some of the normal schools are issuing

bulletins of information and circulars containing directions to teachers along agricultural lines. They are also assisting in organizing rural study clubs, reading circles, and school-house improvement clubs in rural communities.

State and county superintendents have been quite active in a number of States in forwarding this extension movement. One hundred and twenty-three reported forms of assistance in agricultural extension work in which they were participating, such as supplying lecturers for farmers' institutes, sending out itinerant lecturers to visit public schools, holding county teachers' institutes for agricultural instruction, organizing field-crop contests for country children, and in rendering similar practical assistance in extension work.

The realization of the fact that only 6 per cent of the people of this country receive education beyond that given in the common schools is bringing the institutions for higher education to a sense of their responsibility to the remaining 94 per cent and is causing them to set about discovering some means by which this multitude can be reached with at least as much scientific and practical information as will fit them for the intelligent pursuit of their calling. This diffusion of knowledge is especially important in agriculture. The difficulties connected with the profitable pursuit of this occupation have become so great since the more easily available fertility of our soils has been abstracted as to make it essential that those who are to support themselves comfortably in the future by this profession shall understand, at least, the fundamental principles that underlie their art. The educational institutions established mainly in aid of agriculture are and will continue to be properly held accountable for any failure to supply the information needed to meet the requirements that may exist.

In practical recognition of this responsibility, the committee recommends that each land-grant college organize at once a department of extension teaching in agriculture and, where this for any reason is impracticable, that a committee of the faculty be appointed on this subject.

There was no change in the personnel of the standing committee and it proposes pursuing its investigations in greater detail, that it may at some future time be able to recommend a form of extension teaching that will be generally applicable.

The chairman of this committee was recently appointed chairman also of the standing committee on cooperation with other educational agencies of the American Association of Farmers' Institute Workers. The work of the two committees is interrelated to such a degree as to render it possible for them to cooperate to considerable extent in conducting their investigations.

DEPARTMENT AID IN PROMOTING AGRICULTURAL EDUCATION EXTENSION.

A most pressing and important need just now in agriculture is a more effective method for imparting that which is already known to those who are to use the information. The discovery of a practicable method by which the truths of science relating to agriculture can be taught to farmers is fully as important to agriculture now as many of the investigations which are occupying the time and attention of scientists and requiring large annual appropriations to conduct.

The farmers' institute has heretofore been devoted to awakening agricultural people to an appreciation of science as it relates to their occupation. The more important work of imparting these truths to the working farmer in form and in sufficient quantity to be most helpful has scarcely been undertaken, due chiefly to lack of knowledge of the methods best to be pursued in their presentation.

For the discovery of these methods there is needed a force of experts who shall devote their time to researches in this direction. The discovery of pedagogic methods logical in arrangement and adapted to rural conditions through which to impart agricultural information is just now as important to mankind as the discovery of new truths in the physical world. Without new and improved educational machinery for disseminating information, much valuable physical truth, secured at great cost, must lie unused, or if utilized at all be so to only limited extent.

To do this work thoroughly it would be necessary to do more than merely organize for the study of pedagogic forms. It would require first of all systematic study of the social, educational, and economic conditions of agriculture with a view to discovering and suggesting methods for their improvement.

To organize for this it would be necessary to first classify the various interests to be aided and then to employ experts to study the conditions that exist in each class, to recommend methods of improvement, and to urge the adoption of the methods recommended by the classes interested.

The following outline is suggested as a possible classification of institutions whose work would furnish the subjects for a broad investigation of the requirements of agricultural education:

Institutions Concerned in Agricultural Education.

Class I. Farmers' institutes, embracing the work of—
- (1) State farmers' institute directors.
- (2) State farmers' institute lecturers.
- (3) Local managers of farmers' institutes.

CLASS II. Institutions for higher education, embracing the work of—
- (1) Faculties of agriculture in colleges and universities.
- (2) Staffs of the agricultural experiment stations.
- (3) State normal school teachers.
- (4) Agricultural high school teachers.
- (5) Teachers in correspondence schools of agriculture.

CLASS III. Agricultural organizations, embracing the work of—
- (1) State boards and departments of agriculture.
- (2) State agricultural fair associations.
- (3) County agricultural societies.

CLASS IV. Systems of public instruction, embracing the work of—
- (1) State superintendents of public instruction.
- (2) State normal school superintendents.
- (3) County superintendents of public instruction.
- (4) Common and high school superintendents.

CLASS V. Agricultural clubs, embracing the work of—
- (1) Rural women's clubs.
- (2) Boys' and girls' agricultural clubs.
- (3) Rural study clubs.
- (4) Agricultural students' unions.

CLASS VI. Miscellaneous, embracing the work of—
- (1) The Grange.
- (2) Civic associations.
- (3) The agricultural press.
- (4) Libraries.
- (5) Miscellaneous agricultural associations (stock, dairy, horticulture, etc.).
- (6) Industrial departments of transportation companies.

ADDITIONAL WORK OF THE FARMERS' INSTITUTE SPECIALIST.

In addition to that which has been indicated in the foregoing report the institute specialist visited officially during the year 11 States and delivered 20 prepared lectures besides a number of informal addresses and has acted as secretary-treasurer of the American Association of Farmers' Institute Workers.

In addition to his annual report he prepared for the printer copy for the following publications: List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers, and Legislation Relating to Farmers' Institutes in the United States. He also aided in the editing of the Proceedings of the Tenth Annual Meeting of the American Association of Farmers' Institute Workers and the Course in Cheese Making for Movable Schools of Agriculture.

The list of correspondents has increased until now there are over 14,000 names of individuals with whom correspondence is conducted. These lists are classified according to the interests with which the individuals are severally identified.

THE STATE REPORTS.

As the institutes develop, changes of greater or less importance occur in the methods pursued by the several States in conducting their work. In order that these changes may be known and recorded the following brief statements are given under the names of the respective States and Territories calling attention to the features of the institute work in each State and Territory that are worthy of note and likely to prove of value for present information and for future reference:

ALABAMA.

Institute director.—C. A. Cary, professor of veterinary science, Alabama Polytechnic Institute, Auburn.

The legislature of Alabama has made no provision for organizing or maintaining farmers' institutes. The work at present conducted is wholly voluntary and is by the board of trustees of the Polytechnic Institute and of the agricultural experiment station. This board provides for the expenses of the institutes from college and station funds and appoints the director, who is charged with organizing and conducting the work. The board also grants leave of absence to members of the college faculty and of the experiment station staff to give instruction in institute meetings.

During the year fourteen of these instructors participated in this work. The subject of ridding the State of cattle ticks, and thereby of the tick fever, was made a leading topic of institute discussion. An annual round-up, known as the farmers' institute and summer school, was held under the auspices of the Polytechnic Institute at Auburn, in July. The school was continued through 18 sessions and had an average attendance of 337 persons. This is the third yearly meeting of this character that has been held. The degree of interest is indicated by the attendance this year of 207 over that of 1903, and of 92 over that of 1904.

Institute work in Alabama differs from that in most of the Northern States, in that it is distributed throughout all of the months of the year. During last year 85 sessions of institutes were held, with an aggregate attendance of 3,744. In addition to the college and station force ten lecturers were brought in from other States to assist in giving instruction, all of whom were experts in some department of agricultural industry. The small amount of money at the disposal of the State director has greatly interfered with and limited his work, only $600 being available for institute purposes last year.

Institutes for colored people have been conducted under the direction of the Tuskegee Normal and Industrial Institute. The lecture service is performed chiefly by the members of the faculty of the

Industrial Institute and is paid for out of the funds of this institution. The chief work in this direction, however, is at an annual convention or round-up meeting, held at the institution and continuing for two weeks, at which a number of teachers are brought from outside of the State to give instruction.

The failure of the State to make appropriation for institute purposes in Alabama has greatly retarded the development of the work, and it can not be greatly increased or improved until the legislature recognizes its obligation to assist this form of instruction as conducted both by the Agricultural College at Auburn and the Industrial Institute at Tuskegee.

ALASKA.

Institute director.—C. C. Georgeson, special agent in charge of agricultural experiment stations, Sitka.

Agriculture in Alaska can scarcely be said to have reached the institute stage. The districts adapted to farming are widely separated and sparsely settled, making it difficult to do more than confer with and give advice to individuals. This is done by the special agent in charge of the agricultural experiment station at Sitka as he visits the various sections in the interest of his experiment and demonstration work.

ARIZONA.

Institute director.—R. H. Forbes, director of agricultural experiment station, Tucson.

Institute work in Arizona the past year consisted in a series of lectures delivered in an academy at Thatcher, supplemented by side trips to neighboring towns and settlements in the evenings. Twenty-one sessions were held, in this way reaching about 1,300 persons. The institutes are under the control of the regents of the university, who have placed the director of the agricultural experiment station at Tucson in direct charge of the work. The lecturing is almost wholly by members of the experiment station staff, aided by local speakers residing in the vicinity of each meeting.

A number of visits were made during the year to the public schools and lectures delivered before the children and teachers upon nature-study subjects. The leading topic of interest for the Arizona ranchmen is water. The moisture conditions determine the location of every farm, and the securing of an adequate supply of water is consequently of paramount importance in Arizona agriculture. The storage of a sufficient supply and the economic use of water furnish the principal subjects of discussion.

ARKANSAS.

Institute director.—W. G. Vincenheller, director of agricultural experiment station, Fayetteville.

Arkansas held 42 sessions of farmers' institute meetings during the year, with an attendance of 7,150 persons, and at a cost of about $400. The lecturers were members of the experiment station staff, and received no compensation additional to their regular salaries.

The leading subjects discussed were fruit culture, forage crops, and dairying. There has been no recognition of the institutes by the State, consequently, all that has been done has been by the agricultural college and experiment station, with some assistance from the National Department of Agriculture. All of the meetings held were upon special request of the various communities, and a much larger number of invitations were received than it was found possible to meet.

CALIFORNIA.

Institute director.—E. J. Wickson, acting director, agricultural experiment station, Berkeley.

Owing to differences in local climates and leisure seasons in various localities, institutes in California are held every month in the year. The director, who is a university officer, is aided by one assistant superintendent of institutes and two conductors, who have charge of the work in the field.

Last year 272 sessions of institutes were held, in which 22 State lecturers and 197 local speakers participated. The university and experiment station contributed 10 members from their faculty and staff who contributed one hundred days to institute teaching.

A State round-up meeting continuing for 8 sessions was held at Berkeley, with an attendance of 2,500 persons. This meeting has been very successful in interesting the farmers of the State in the agricultural college and experiment station and in popularizing and improving the institute work.

The attendance last year at the general institutes was 22,861 and the cost was $9,000, of which $6,000 was from the State appropriation and $3,000 from the general fund of the University of California. A new feature of the work for the year was the formal and organized cooperation of the institutes with the State Teachers' Association, whereby a farmers' institute section was organized in the annual State Teachers' Convention. For the coming year this representation is to be extended to provide a section on farmers' institutes in every district teachers' association. The school teachers of California are enthusiastically in favor of the institute and are doing all that they can to promote its interests.

A brief report of the institute proceedings is prepared each year by the State director and 12,500 copies are published and distributed by the experiment station. Much of the instruction given in the institute is special. Viticulture, for example, was made a leading topic last year in the grape-growing districts. In other sections devoted to special crops a similar method is pursued and the consideration of these crops is made a special feature, extending through all of the institutes of that particular section.

A lady lecturer on domestic science was regularly employed last year, and some entire sessions were devoted to that subject with the effect of increasing the interest and greatly extending the usefulness of the institutes.

COLORADO.

Institute director.—Fred P. Johnson, superintendent of farmers' institutes, Denver.

The first appropriation for farmers' institutes ever made in Colorado was in April, 1905, and became available the following August. The amount was $8,000 to cover two years and to be expended under the direction of the State board of agriculture, which is also the governing board of the State Agricultural College. On the 1st of August, 1905, Mr. Fred P. Johnson was appointed superintendent of farmers' institutes and since that time the work has been under his supervision, assisted by, and in cooperation with, the dean of the faculty of agriculture in the Agricultural College.

The work during the year has been largely in the way of organization and instruction. For this reason most of the time at the institute has been given up to the visiting lecturers. The usual method has been to introduce a subject in a brief talk of fifteen or twenty minutes and then induce the audience to ask questions and secure addresses from local men covering their experiences along the lines of the subjects under discussion. At the evening sessions, lectures illustrated by a stereoscope are frequently given and at others the audience is divided, the women and men holding separate sessions. Another feature that has proven very helpful has been that of outdoor stock-judging lectures, at which stock is brought into a ring and their points discussed by the lecturer and questions asked by the audience. Another feature just introduced, is that of small institutes on farms taking the people directly into the field and discussing the subjects there in the midst of practical illustrations. The director has also held normal institutes in which the meetings continue for four or five days, consisting principally of field work and lectures upon specified topics which are thoroughly exhausted during the institute. For these institutes the director requires that at least twenty farmers shall agree to attend all of the sessions and provide facilities for reaching the fields. This is a departure from the old methods in conducting normal institutes and its progress will be watched with interest.

It is expected that two corps of lecturers will be organized for the coming year. The basis for the lecture force has been the agricultural college and the experiment station men. Gradually some excellent workers are being developed among the farmers of the State. In order to encourage the attendance and assist in the advertising, the director expects for the coming year to require a petition signed by some 50 to 200 names requesting the institute and agreeing to attend the sessions. These petitions will be circulated in advance among the farmers for signature.

One hundred and twenty-three sessions of institutes were held last year, with an attendance of 16,675, at a total cost of $3,300. In addition to these, 5 independent institutes were held, with an estimated attendance of 3,000. There were 26 sessions of women's institutes held in connection with the regular meetings. The college and station men contributed two hundred and ninety-five days of time to the work. An account of the proceedings of the institutes will be prepared, and an edition of 10,000 published and distributed.

CONNECTICUT.

Institute directors.—James F. Brown, secretary State board of agriculture, North Stonington; J. G. Schwink, jr., secretary Connecticut Dairymen's Association, Meriden; H. C. C. Miles, secretary Connecticut Pomological Society, Milford.

The division of the institute work in Connecticut between three distinct organizations is unique in farmers' institute management in this country. The State board of agriculture, the State Dairymen's Association, and the State Pomological Society, through their respective secretaries, have each held institutes devoted largely to the special lines of work which each organization represents. No report has been received of what has been accomplished by the State board of agriculture during the year. The other two societies, however, have been active in institute work. The dairymen's association held 39 sessions of regular institutes in addition to its annual convention, consisting of 5 sessions. The regular institutes were attended by 3,345 and the annual institute by 3,300. Forty-two speakers were present at the institutes of this society and delivered 96 addresses. Fifteen hundred dollars was expended in carrying on the work.

The Connecticut Dairymen's Association was organized about twenty-five years ago to develop and improve the dairy interests of the State. Its present membership is about 460. For the past twenty years the association has received an annual appropriation from the State to aid in carrying on its work, but owing to the popular demand for more institutes the sum was found to be insufficient, and $500 additional was granted by the last legislature. The influences that have gone out from these meetings are now seen in all parts of the State. New barns and stables have been erected after

the most approved methods of sanitary construction; dairy herds are more economically and intelligently fed and cared for than formerly; silos have been built; the science of breeding and rearing dairy cows is receiving greater attention, and the preservation of soil fertility is more carefully studied. The association cooperates with the granges and farm clubs of the State in its meetings, and is employing the leading experts in dairying as instructors in its institutes.

The Pomological Society has been doing a similar work for the fruit interests of the State. This society held 44 sessions of institutes, with an attendance of 1,550 persons, and at an expenditure of $325. One independent institute was held with an estimated attendance of 2,500. The State Agricultural College and the experiment stations aided in the teaching by sending 11 of their instructors, who contributed forty days of their time to this service. Special attention was directed in the institutes this year to the control of the San José scale. Institutes were held in all of the eight counties of the State, most of them being in cooperation with the local granges. Most of the meetings were day sessions, the attendance at the evening sessions being found to be unsatisfactory.

The institutes are exerting a very helpful influence upon the agriculture of the State, and they will doubtless continue for some time to divide their work among the three agricultural organizations heretofore in charge. It is believed, however, that ultimately the State will find it necessary to make a change in its system by combining its institute forces and enlarging its efforts with a central official in charge. This has been found most efficient elsewhere in institute organization, and no doubt it will be adopted in Connecticut as soon as educational agencies become the dominant feature in institute effort.

DELAWARE.

Institute director.—Wesley Webb, secretary of the State board of agriculture, Dover.

Institutes were held in all of the three counties of Delaware last year. In Kent and Sussex counties the institutes were arranged by the State director, and in Newcastle County by the executive committee of the county institute.

The number of institutes held was 18, made up of 40 sessions. The total cost for the year of the institute work was $700. The experiment station furnished one speaker for twelve days and the State director supplied seven additional lecturers. A report of the institutes is published each year in the annual report of the State board of agriculture and about 5,000 copies are distributed. The law requires that an institute organization shall be effected in each county and appropriates $200 to each for their maintenance. The failure of any county to hold an institute causes it to forfeit its appropriation for that year.

FLORIDA.

Institute director.—R. W. Clothier, professor of agriculture, University of Florida, Gainesville.

The institutes have been temporarily suspended in Florida, owing to the failure of the legislature to make appropriation for their support. This was due to a readjustment and reorganization of the educational work of the State which was quite radical. The institute work in previous years was under the direction of the agricultural college, but the reorganization referred to, in which the State legislature abolished the university, together with five other educational institutions and provided for a university and a woman's college, a normal school for colored students and an institution for the deaf, dumb, and blind in their stead, placed all under a single State board of control. This board has recently determined to remove the university from Lake City to Gainesville.

These changes in the educational management have for the time prevented the university from continuing the work in institute directions which it has formerly conducted. As soon as the university becomes settled in its new location, the institute work will doubtless be resumed and proper appropriation for its maintenance be made by the State.

GEORGIA.

Institute director.—H. C. White, president Agricultural College, Athens; Harvie Jordan, field agent in charge of farmers' institutes, Atlanta.

The legislature of Georgia in 1904 appropriated $2,500 to the University of Georgia for farmers' institute work and has continued this appropriation each year since that date. This year the number of institutes fell off from 44 to 21 and the attendance from 18,000 to 4,500. No report has been received explanatory of this sudden change.

There were six State speakers on the corps of lecturers, three of whom were from the experiment stations. No independent or special institutes are reported, neither were women's nor boys' sessions held. The actual expenses for institute work for the year were $2,500. The organization is by senatorial districts and not by counties.

HAWAII.

Institute director.—Jared G. Smith, agent in charge of agricultural experiment stations, Honolulu.

Institute work in Hawaii last year consisted of four quarterly meetings, each continuing two days. These meetings were attended by about 300 persons and were conducted by the officers of the agricultural experiment station.

Since the organization of the farmers' institute of Hawaii, the annual meetings have been held at the Kamehameha School for Boys, which has an agricultural course in connection with mechanical training. The students all attend this annual farmers' intstitute.

During the last several meetings of the farmers' institutes of Hawaii, an effort has been made to have the subjects of the several addresses of each meeting pertain to a single definite branch of agriculture, rather than to discuss subjects widely removed from each other. In furtherance of this, special topics are arranged in advance for discussion in the open meeting, giving definite notice to and sufficient time for preparation by those who desire to participate in the discussions.

IDAHO.

Institute director.—H. T. French, director Agricultural Experiment Station, Moscow.

The difficulties connected with the holding of farmers' institutes in Idaho are principally geographical. The peculiar conformation of the State, the mountain chains which divide it, and the transportation facilities, together with the sparse population, all contribute to making the work time-consuming and expensive. Were it not for the fact that the railroads furnish free transportation to institute workers it would be impossible with the $1,000 appropriated for institute work to carry it on creditably. In one instance the institute director was compelled to travel over 1,000 miles to reach the institute locality, and that single trip in which comparatively few institutes were held involved over 2,000 miles of travel.

Twenty-one institutes were held last year, consisting of 105 sessions. They were attended by 7,875 persons. There was an independent institute with an attendance of 150 persons. A very satisfactory normal institute, attended by about 500 persons was held at Caldwell. In connection with this normal institute was a woman's department which was well attended and developed a great deal of interest. The pronounced success of this meeting has led to arrangements for holding another in a different section of the State. Invitations have come to the director from a number of points requesting that the normal institute be held in their locality and offering to provide a meeting hall and pay all of the other necessary expenses.

There were three lecturers upon the State force and 26 local speakers assisted in giving instruction. The agricultural college and experiment station together sent out 9 men at different times to deliver lectures who together contributed about forty days of service.

The appropriation for institute purposes amounting to $1,000 per year is made to the board of regents of the University of Idaho, who turn over this appropriation to the director of the agricultural experiment station, who is also director of farmers' institutes, to be used by him for institute purposes.

ILLINOIS.

Institute director.—F. H. Hall, superintendent of farmers' institutes, Aurora.

The institute system of Illinois is altogether different from that of any other State. It is known as the Illinois Farmers' Institute, and is managed by a board of directors, consisting of the State superintendent of public instruction, the professor of agriculture of the University of Illinois, the president of the State board of agriculture, the president of the State Horticultural Society, the president of the State Dairymen's Association, and one member from each Congressional district of the State, selected by delegates from the district present at the annual meeting. This board of directors elects a secretary and superintendent of farmers' institutes. In the present instance these offices are combined in one individual.

The county institutes are the units in the State system, and are regularly organized under a State law, and are each entitled to an appropriation of $75 per year contingent upon their holding one or more institutes of not less than two days' duration, and of which proper public notice has been previously given.

The employment of speakers is altogether in the hands of the local institutes as well as the duty of making arrangements for holding the institute, such as selecting the location, the preparation of the programme, and securing entertainment for institute speakers.

Last year 108 institutes, composed of 667 sessions, were held with an attendance of 79,428 persons. The State University contributed 30 men for giving instruction who devoted in the aggregate two hundred and thirty-nine days to this work. There were six independent institutes held, with an attendance of 1,440 persons, and there was also the round-up or annual meeting of 8 sessions with an attendance of 6,000.

All of the trunk lines of the railroads provided special trains free of charge, which were run over their several lines. These trains were equipped by the State University, so far as lecture force and illustrative material were concerned. The train furnished by the Chicago, Burlington and Quincy Railroad was out eight days, and reached by actual count 16,630 people. The Illinois Central was out eleven days, and reached 20,817 persons. The Wabash furnished a train for three days, during which time about 1,000 people were met. The interest aroused by these trains was much greater than had been anticipated, and was manifested not merely by the attendance, but by applications that were afterwards received by the university and the agricultural experiment station for literature. Reference was made by the applicants to statements made by the lecturers from these railroad trains.

A feature of the Illinois institute is the boys' class. In each institute there is a boys' class devoted wholly to giving instruction to boys and to exercises in which they are specially interested. Corn judging, stock judging, the reading of papers which the boys have prepared, speaking selections, undergoing examinations, etc., are some of the exercises.

About one-half day of each institute is conducted by the women. There are domestic science associations in sixty of the counties which hold regular meetings in addition to the farmers' institutes. The effect of these associations has been to greatly strengthen the institute work particularly in its relation to the farm home.

Corn-judging contests for boys were held in twenty-nine counties last year and the prospects are that upward of fifty counties will adopt them in the coming year. This method of interesting young people was devised by Hon. A. P. Grout, of Winchester, Ill. It provides for a test of skill in the judging of corn, the premium being a trip to the agricultural college for two weeks' instruction in subjects of practical importance to young men on a farm. Last winter about 75 boys were sent to this winter short course at the college through these contests, and as many more went at their own expense, who became interested through the institutes. One county sent one boy and paid half of the expenses of another, and another county offered the short-course premium to one boy in each township in the county.

This year bread-judging contests are open to girls in a few counties, the premium being a trip to the agricultural college with two weeks' instruction in household science.

The Business Men's Association in Scott County offered a prize of $10 to one boy in each of the thirteen election precincts of the county toward paying his expenses to the winter short course at the agricultural college. The method adopted in making the selection last year was to distribute a 14-page bulletin on Soil Fertility among the young people in the public schools, who were requested to study the bulletin and report at the next farmers' institute meeting for examination, the one standing highest in each precinct to receive the prize. Fifteen boys, representing nine precincts, applied for examination, and one from each precinct was awarded the premium.

There was appropriated to the farmers' institute last year in Illinois $30,281.55, the largest amount given to institute work by any State. This is received from the following sources: From the State for use of the local institute organizations, $7,650; from the State for the use of the State board of agriculture and for the payment of the salary of the superintendent of farmers' institutes, $7,500; from the State for the payment of the salary of the secretary, $2,000; from the county board of supervisors for institute purposes, $2,555; from donations, membership dues, and sale of exhibits, $10,576.55.

Twenty thousand copies of reports of the farmers' institute proceedings are published and distributed each year.

INDIANA.

Institute director—W. C. Latta, professor of agriculture, Purdue University, Lafayette.

That the institutes in Indiana are making substantial progress is shown to some extent at least by the fact that the number of sessions has increased from 883 in the year ended June 30, 1905, to 918 in the year ended June 30, 1906. The average attendance at each session in 1906 was 141, and the amount appropriated for institute purposes was $12,500.

A conference of the institute workers held each year at Purdue University has materially aided in advancing the institute work. At the conference held in October, 1905, special attention was given to the consideration of methods for interesting boys and girls in the institutes. In several counties the county superintendents of schools in cooperation with the county chairman of the farmers' institutes organized boys' and girls' clubs for growing corn, making bread, etc., the products to be exhibited at the institute in competition. Premiums were offered by the business men of the districts interested and many boys were induced to enter in competition.

In compliance with numerous requests by county chairmen a trained domestic-science teacher was employed last year for the entire institute season to lecture upon food, household management, home making, and kindred topics. Seventy-two institutes were attended by this instructor, and the lectures were received with great interest by almost every locality visited by the domestic-science teacher. This year requests have been sent in to the State director for similar instruction in the future.

A number of independent institutes were held with a reported attendance of about 100 in each. Women's meetings were also held, usually in connection with the regular institutes. About 20 separate sessions and a like number of special sessions were conducted by women.

The agricultural college and experiment station furnished 5 lecturers, who gave twenty-seven days of their time to the institutes. In addition to these there were 44 other lecturers in the employ of the State director and about 50 local essayists and speakers. About 1,000 copies of the annual report of the institute work are printed and distributed each year. The reports do not give the proceedings at the several institute meetings, but present statistical information showing the condition and progress of the institute work for the preceding year.

IOWA.

Institute director.—J. C. Simpson, secretary State board of agriculture, Des Moines.

In Iowa the institutes are held by the county institute organizations independently of each other and without State supervision. Each county society, however, is required to file a brief report in the office of the State department of agriculture if it desires a voice in the annual agricultural convention. Before any local institute society can receive its appropriation from the county treasurer, amounting to a sum not to exceed $75 annually, the managers must file affidavits, with the bills of actual expenses attached, with the State auditor, to be approved by him.

The reports as far as they have been sent in this year to the secretary of the department of agriculture show that 402 sessions of institutes were held during the year, having an attendance of 66,959. The total expenses for the 69 counties reporting out of a total of 99 in the State were $8,096.06. An annual meeting called a State Farmers' Institute was held in Des Moines in December, at which there was an attendance of about 200 persons. Some of the best papers at the institutes are collected annually by the secretary of the board, and are published in the Yearbook of agriculture, issued by the agricultural department.

KANSAS.

Institute director.—J. H. Miller, superintendent of farmers' institutes, Manhattan.

In Kansas, in addition to the State appropriation of $2,000 annually made to the State agricultural college for farmers' institute purposes, each county institute is entitled to $50 annually, for meeting its local expenses. Five hundred and twenty-two sessions of institutes were held last year, with an attendance of 27,300.

The agricultural college and experiment station at Manhattan have taken very active interest in this work. Twenty-one members of their force of teachers and experiment station experts were engaged in lecturing before institute audiences during the past year. Their work was supplemented by a force of local speakers numbering 406, who either read papers or delivered addresses. In addition to the regular institutes there were 14 that were independent, having a reported attendance of 8,000. A corn and wheat special was run by the Rock Island Railroad for twelve days. During that time the train made 135 stops. It consisted of one baggage car, two lecture cars, and one living car. Four members of the agricultural experiment station force accompanied the train as lecturers, and during the period delivered 236 addresses and met 10,000 people.

County institutes have been regularly organized in 85 counties, and boys' corn contests were held in over 50 counties, which included in their membership about 6,000 boys.

KENTUCKY.

Institute director.—Hubert Vreeland, commissioner of agriculture, Frankfort.

Under a recent act of the legislature of Kentucky it is made the duty of the commissioner of agriculture, labor, and statistics to see that a "farmers' and an industrial institute" of at least two days' duration is held each year in every county in the State. Each county institute is entitled to send one or more delegates to attend a State institute of at last "three days' duration." These delegates are empowered to elect members of the State board of agriculture, forestry, and immigration. An appropriation of $15,000 per year was made for farmers' institute work. The new law does not go into effect, however, until 1907.

During the year ended June 30, 1906, 25 institutes were held; 24 were of two days' duration, making a total of 122 sessions. The average cost of these institutes was about $70.

The director is arranging for a large increase in the number of institutes to be held next year. With this in view he has divided the State into four institute districts and intends to keep four corps of men in the field during the institute season. With the increased appropriation and the better organization of the work the institutes can be carried into every county of the State and be thoroughly equipped with experienced teachers. The general round-up meeting of agricultural people held under the auspices of the State board of agriculture convened at Frankfort in February. This was the first State institute ever held in Kentucky, and was well attended by representative farmers from all over the State and continued in session for three days.

The institutes have now been organized in many of the counties of the State and all that will be necessary in the future will be to see that the State lecture force is thoroughly equipped for its work and that the institute meetings are well advertised in the several communities.

LOUISIANA.

Institute director.—Charles Schuler, commissioner State board of agriculture and immigration, Baton Rouge.

The institute work was greatly interfered with last year in Louisiana by the outbreak of yellow fever in July and the consequent quarantining of various sections of the State. Only 13 institutes were held, consisting of two sessions each. The total attendance was 2,657.

The amount appropriated for institute purposes was $2,000, which was used chiefly for defraying the traveling expenses of the State lecturers, who for the most part are from the faculty of the agricultural college and experiment station staff. Twenty-two local speakers addressed institute meetings, in addition to the college and station

men. The leading features in the work this year were domestic science and dairying. An expert poultryman was also on the lecture force for almost the entire period.

MAINE.

Institute director.—A. W. Gilman, commissioner of agriculture, Augusta.

During the past year the University of Maine, the State board of agriculture, the Bangor and Aroostook Railroad, and the Maine Central Railroad Company, working in conjunction, ran two special trains. The trip over the Bangor and Aroostook Railroad occupied eleven days, 31 meetings being held, with an attendance of about 20,000 persons. The other trip over the Bangor and Maine Railroad occupied fifteen days, with 45 meetings and an attendance of 35,000.

The trains consisted of three baggage cars, in which were placed by the college of agriculture and the experiment station exhibits showing appliances for dairy work, poultry rearing, orcharding, gardening, seed testing, and educational displays of fertilizers, feeds, a veterinary exhibit, and forestry and paper mill exhibits.

At least two hours were spent at each stop, during which time two or three lectures were given from the station platform or in the cars, and the people were shown the practical use of the appliances on the train.

In addition to this special train service, there were 50 one-day institutes held, consisting of 102 sessions, with a total attendance of 6,967 persons. The amount appropriated for institute purposes, including the salary of the superintendent, was $5,000. Two institutes were held in each county as required by law, and the remainder were apportioned among the counties according to the extent of their agricultural interests.

There were 10 independent institutes held with an average estimated attendance of 125. A summary of the proceedings and a few selected papers that had been read before the institutes were published in the annual report of the department, of which 6,000 copies were printed. About 40 local speakers addressed the institutes, besides 17 lecturers employed by the State director. Two members of the faculty of the University of Maine contributed twenty days of service as lecturers.

MARYLAND.

Institute director.—W. L. Amoss, director of farmers' institutes, Benson.

Institute work in Maryland the past year was quite diversified in character. A railroad corn special, a strawberry special, a sweet potato special, a tobacco special, a milk special, and a steamboat special were sent out at various times in the interest of the several products indicated by these names. The diverse character of the

farming interests of Maryland, by which certain localities are largely devoted to growing special crops, render it necessary to vary the instruction to suit each particular district. About 3,100 people were met and given instruction by expert specialists who accompanied these special trains and the steamboat special. Forty-nine regular institutes were held in addition to the railroad meetings, attended by 10,762 persons and consisting of 125 sessions.

One institute for colored people was held, with an attendance of about 150. This meeting was a pronounced success; the papers and discussions were both practical and helpful.

The institute undertook this year to cooperate with the agricultural experiment station in exhibiting agricultural products at several county fairs. An effort was made to mingle entertainment with instruction, so as to secure the attention of visitors and take advantage of the opportunity at the same time to offer some wholesome advice. A tent was fitted up with comfortable seats and supplied with a corps of institute representatives. Use was made of the phonograph, the stereopticon, and large colored photographs. These were selected with a view both to providing entertainment as well as instruction. Popular airs were rendered, followed by a brief address by the phonograph and the exhibit of stereopticon views, together with explanations by the operator in charge.

As an expedient for meeting the sensational fakir on his own ground, the method seemed to be fairly successful. Just how far an educational institution should go in this direction is a matter that experience only can determine. Its value in any case will always be dependent upon the judgment exercised in the selection of material for presentation.

An important experiment was conducted by the institute director in the direction of introducing agriculture into the public schools. A capable teacher of agriculture was sent into one of the leading counties one day each week to visit the rural schools and lecture before the children upon some phase of agricultural science or practice. The selection of the schools in which the instruction was given was found, after a trial, to have been on some accounts unfortunate, and the results, consequently, were not up to the expectation of the friends of the movement, although the great possibilities that lie in this direction were quite clearly demonstrated.

MASSACHUSETTS.

Institute director.—J. L. Ellsworth, secretary State board agriculture, Boston.

There were 153 sessions of institutes held last year in Massachusetts, attended by 19,125 persons. The average attendance at each session was 125. The work was conducted at a total cost of $1,760.44,

or at the rate of $11.51 per session. A feature which gave great satisfaction, and which it is proposed to greatly extend next year, was the field meeting. These meetings were held, as the name indicates, out in the fields, the lecturers using the growing crops for demonstration purposes. Great interest was awakened among the farmers by this method of instruction, as is evidenced by the fact that one meeting was attended by upward of 1,000 persons.

A better farm special railroad train was run over the Boston and Maine system, reaching about 6,000 people. It made twenty-five stops in Massachusetts, and at each stop lectures were delivered and exhibits inspected. In Massachusetts all of the time of the institute is given to the State lecturers. This year there were 13 on the instruction force, all of whom were from the agricultural college and the experiment station.

MICHIGAN.

Institute director.—L. R. Taft, superintendent farmers' institutes, Agricultural College.

The institutes of Michigan for the year ended June 30, 1906, surpassed those of the previous year in the number of sessions held by 107 and in the number of institutes by 65. The attendance was 122,573, being an average of 128 persons per session. There were also a number of institute picnics held and special trains run. The trains ran for nine days, making forty-nine stops and reaching about 5,000 people. In the general institutes 51 sessions of these meetings were women's sessions—a feature of Michigan institutes rapidly developing. The appropriation for institute work was $7,500 by the State board and an equal amount additional for local expenses. Thirteen members of the faculty of the agricultural college and of the experiment station gave one hundred days of time to lecturing in the institutes. Meetings were held during the year in all of the counties excepting ten. The number of one-day institutes was 259, the largest number of one-day institutes held in any State.

A meeting of the institute lecturers, continuing for a week, was held at the agricultural college. The purpose was to bring the instruction force in touch with the college and experiment station work and to give them, through lectures and demonstrations, the latest information and discoveries in agricultural science. These meetings were well attended, and the interest manifested in the course of instruction was all that could have been desired.

Reports containing statistics of attendance, lists of officers, and the proceedings of the annual meeting, together with such papers of excellence as had been read at the county institutes, were edited by the State superintendent and 9,000 copies published and distributed.

MINNESOTA.

Institute director.—O. C. Gregg, director of farmers' institutes, Lynd.

In Minnesota a new feature in institute work was introduced last year. Short courses in agriculture, continuing for a week, were given at various points. Before arranging for such a course in any locality pledges from a considerable number of farmers were first secured agreeing to attend all of the sessions. The meetings are reported to have been quite successful, and it is proposed to continue and extend them the coming year.

A railroad special "good-seed train" was equipped and run, reaching about 900 persons and making twelve stops. The regular institutes numbered 105, composed of 238 sessions, with an aggregate attendance of 51,211. The total cost of the institutes was $20,200, of which $18,000 was from the State appropriation and $2,200 from advertising in the institute annual. There were ten State lecturers employed, four being from the agricultural college. An institute annual, containing papers and addresses delivered at farmers' institutes, was prepared and published by the institute board of administration, and 35,000 copies were distributed.

MISSISSIPPI.

Institute director.—E. R. Lloyd, director of farmers' institutes, Agricultural College.

The yellow-fever epidemic which broke out in the South, and the quarantine which followed in July, 1905, interfered seriously with institute work in Mississippi. Notwithstanding this, 220 sessions of institutes were held, with a total attendance of 10,000 persons. The agricultural college and experiment station men performed about 75 per cent of the institute work. Eighteen of these instructors taught in the institutes this year, contributing three hundred and sixty days of their time. This is the highest number of days given by a land-grant college to institute work in any State this year.

The present appropriation of $3,000 is altogether inadequate for supplying institutes in sufficient number to meet the demand. During the year as many as eight requests came in from a single county for institute meetings. Most meetings in Mississippi are held during July, August, and September. At this season of the year most of the crops have been "laid by" and farmers have more leisure time for attendance upon the meetings than at any other season. This is also the vacation period of the college and the experiment station men, who compose the corps of institute lecturers.

A round-up meeting of three days was held at the agricultural college, with an attendance of about 200. A diversified farming special was run over the lines of the Illinois Central and the Yazoo and Mississippi Valley Railroad systems during the year. The train con-

sisted of two day coaches fitted with raised platforms for speakers, a baggage car, a diner, and a sleeper. The entire train was furnished by the railroad companies without cost to the institute management. The train made seventy-five stops in the State, and the attendance upon the lectures at these stations numbered 9,127.

A feature of the institute, as conducted this year, worthy of notice is that of utilizing the spare time before the institute opens in the morning and after it closes in the afternoon in visiting near-by farms and conferring with the farmers respecting the introduction of better methods in their systems of agriculture. In some instances practical demonstrations were given on individual farms. Among these were demonstrations of the method of terracing and draining land. The effect of this intermingling in a social and educational way has been to establish a feeling of confidence among the farmers in the ability of the institute teachers to give practical and useful instruction.

MISSOURI.

Institute director.—George B. Ellis, secretary State board of agriculture, Columbia.

The total number of institutes held in Missouri during the year was 156, an increase of 52 over the previous year, when a technical decision by the State auditor prevented the use of $1,900 of the State appropriation. One hundred of these meetings were for one day, 55 for two days, and 1 for three days, making a total of 410 sessions with a total attendance of 36,900, or an average of 90 per session. Twenty-eight lecturers were upon the State institute force, of whom about half were from the agricultural college and the experiment station.

The three leading topics for discussion were "Corn improvement," "Better roads for Missouri," and "Dairying." Of these "Corn improvement" was taken up at practically every meeting.

The funds available were $5,000, entirely derived from State appropriation. A portion of this amount is available for printing reports of the meetings, the proceedings of which are published in part.

MONTANA.

Institute director.—F. B. Linfield, director agricultural experiment station, Bozeman.

Montana has over 145,000 square miles of territory and had in 1900 a population of 243,329. The sparsely settled condition of the country, its great extent, and the lack of railroads in many sections make the institute problem one of considerable difficulty. The State appropriated $4,000 per year for institute purposes. At least one institute is required to be held in each county each year. For convenience, the State has been divided into institute districts composed

of several counties. Each district is visited by a corps of institute lecturers, who hold meetings in each of the counties composing the district. The local county organizations are required to provide suitable halls and must furnish them with light and heat and bear all necessary advertising expenses.

Last year 133 sessions of institutes were held, attended by 7,890 persons. Twelve independent institutes, with an estimated attendance of 345, were also held during the year. In addition to the regular institute work, a dairy instructor was sent out to give instruction and demonstrations in connection with the creameries of the State. The most of the instruction in the regular institutes is given by members of the faculty of the agricultural college or of the experiment station. Eight of these lecturers were employed this year for an aggregate of one hundred and ten days. Forty-two local speakers also assisted in the teaching.

A report of the proceedings of the institute is published annually, and 5,000 copies are distributed. A bulletin announcing the meetings and giving a list of the speakers is prepared and sent out each year to the various institute organizations and localities in which institutes are proposed to be held.

NEBRASKA.

Institute directors.—E. A. Burnett, director agricultural experiment station, Lincoln; Val Keyser, assistant superintendent farmers' institute, Fairbury.

The attendance at the institutes this year in Nebraska was greater than ever before. Seventy-two thousand eight hundred and ninety-four persons are reported as having been present. The number of institutes increased from 150 in 1904–5 to 160 in 1905–6, and the number of sessions from 480 in 1904–5 to 515 in 1905–6. At many places this season where meetings were held in the largest halls the town afforded scores of persons were turned away for lack of hall capacity. At other places overflow meetings were held and the exhibit rooms were thrown open.

The system combines local and central organization. No institutes are held except upon request, and the community is always expected to bear part of the expenses, generally amounting to the hall rent, cost of local advertising, and the entertainment of the speakers at hotels. The local organizations have a president, a secretary and treasurer, and a local committee to look after the expenses and the printing of the programme. The central office prints posters and special notices of the meetings and sends them out to the local secretaries and to the newspapers. The various railroad companies furnish free transportation to the speakers upon request to the central office.

The last legislature passed an act which became operative in July, 1905, authorizing the board of county commissioners of any county to defray the local expenses connected with farmers' institutes in that county not to exceed $100 per annum in any county. Before any farmers' institute can take advantage of this appropriation it must be organized with a president, a secretary, a treasurer, and an executive board of not less than three members, and a signed membership of not less than fifty actual farmers; and the further provision is made that no money shall be paid for the expenses of any institute not held in cooperation with the University of Nebraska.

No round-up institute is held on account of the large popular meetings held by organized agriculture at the school of agriculture and experiment station at Lincoln, the third week of January in each year. All of the societies for the promotion of the different lines of agriculture meet at this time. In January, 1905, these societies held 31 different sessions, with a total attendance of over 2,000.

Good seed specials, accompanied by institute speakers, were sent out during the year from which 34,092 people were addressed. The total cost of the institutes was about $8,607. Six thousand dollars of this was from the State appropriation and $2,607 for meeting the bills for local expenses reported and paid by the county commissioners. The agricultural college and experiment station sent 15 men as lecturers, who contributed one hundred and fifty days of time to the work.

The institutes of Nebraska are well organized and the system is worthy of careful study by other States.

NEVADA.

Institute director.—J. E. Stubbs, president Nevada State University, Reno.

No institutes were held during the year.

NEW HAMPSHIRE.

Institute director.—N. J. Batchelder, secretary State board of agriculture, Concord.

A farmers' institute meeting was held in every county in New Hampshire last year. There were in all 34 sessions, with an attendance of 3,000, at a total cost of $2,100. There were 15 lecturers on the State force, 8 of whom were members of the agricultural college faculty. The institutes are held under general authority given by an act of assembly, which requires the secretary of the State board of agriculture "to make arrangements for, give public notice of, and, if possible, personally attend the farmers' meeting authorized by the board." The dates, places, and programmes of the institutes are arranged by the county members of the board in connection with the secretary, and notice of the meetings are printed one month in advance of their occurrence.

NEW JERSEY.

Institute director.—Franklin Dye, secretary State board of agriculture, Trenton.

In New Jersey last year special stress was laid in the institute meetings upon the necessity for the farmer being an educated man—an agriculturally educated man. The fact was emphasized that the chief reason why the earth has not yielded her fullest harvests is due to the stupidity or ignorance of those who have tilled the soil—that the soils have possibilities not yet reached and can only be developed by bringing to their treatment greater skill and more intelligent understanding and application of the forces that affect life and growth.

Eleven thousand six hundred and eleven persons were met and instructed in the institutes of the State last year. One hundred and sixteen sessions were held, not including the annual meeting of the board, which consisted of seven sessions and was attended by about 1,200 persons. There were nine speakers upon the force of lecturers, four of whom were from the agricultural college and the experiment station. The college and station men contributed sixty-six days of their time in lecturing before institute audiences. The total cost of the institute was about $3,000, which was paid out of the $8,000 appropriated to the State board of agriculture. Arrangements for institutes are made by the State director after conference with the county boards of agriculture and the local granges.

NEW MEXICO.

Institute director.—J. D. Tinsley, superintendent of farmers' institutes, Agricultural College.

There were no farmers' institutes held in New Mexico last year, owing to the failure of the Territorial legislature to grant an appropriation for their support. An effort will be made this coming winter to secure funds that will enable the work to be resumed. In anticipation of this Prof. J. D. Tinsley has recently been appointed superintendent of institutes, and he has already taken steps to organize local institute societies in the several districts. In addition to the regular institute work in which these societies will be expected to continue, experiments will also be carried on in cooperation with the agricultural experiment station. A very complete form of constitution and by-laws for an institute organization has been prepared and is being distributed for signature throughout the Territory.

NEW YORK.

Institute director.—F. E. Dawley, director of farmers' institutes, Fayetteville.

New York held 1,062 sessions of farmers' institutes last year, attended by 134,989 persons, or an average per session of 126. There were also held 23 independent institutes with an estimated attendance of 19,800. The annual appropriation for institute purposes is $20,000.

The State lecture force has on its roll the names of 70 persons, and during the year about 400 other teachers, essayists, and local speakers assisted in giving instruction at the institute meetings. A two-weeks normal institute was held, one week at the experiment station at Geneva, and the next week at Cornell University. At this institute the State lecturers were expected to be present. The sessions were addressed by station and college men, each presenting and explaining the progress of agricultural science in his specialty during the year. Complete syllabuses of the lectures were printed and handed to the members of the normal class and special periods were set aside for their discussion.

The results of this method of instructing the lecturers and securing uniformity of statement in their teaching before institutes have been most satisfactory. Twenty-two agricultural college and experiment station men lectured before the institutes during the year, devoting in the aggregate two hundred and thirty days of time to this work. There were 120 sessions of boys' institutes held with excellent results. Each year 15,000 copies of institute proceedings are published and distributed, 10,000 copies through members of the legislature and 5,000 through the department of agriculture. Three special topics were made leading subjects in institute discussions for the year—rural schools, good roads, and alfalfa.

NORTH DAKOTA.

Institute director.—E. E. Kaufman, superintendent of farmers' institutes, Fargo.

Special seed trains were sent out in North Dakota this year, continuing on the road in the aggregate twenty-two days and making one hundred and fifty stops. At each stop lectures were delivered and specimens exhibited before audiences of farmers. Seventeen thousand six hundred and ninety-six persons were at these meetings. The stops were about three-quarters of an hour each, except that in the evenings meetings for from about half past 6 to half past 9 o'clock were held, after which the train would leave for the next place scheduled for the first hour the next morning. The lecturers were confined to one or two topics, illustrating them by specimens and in some cases by demonstrations. One of these trains was utilized as an "emergency special" to carry abroad, just before seeding, information respecting the treatment of seed to prevent rust. The plan was to cover as large a part of the wheat and flax growing districts as possible in the shortest time, thus endeavoring to induce as large a number of farmers as possible to treat their seed for the destruction of spores before planting.

The institute work in general was quite as successful as in previous years. One hundred and sixty-two sessions were held and 20,310 persons reached. The average attendance at each session was 125.

There was available for institute purposes $6,379.07, of which $5,577.16 was used. The appropriation by the State for the coming year is $6,000. The agricultural college furnished four men from its faculty for institute service, who gave thirty-five days to the work. There was one independent institute held with an estimated attendance of 6,430, a general convention of the farmers of the State. Each year, 10,000 copies of an annual institute report are published and distributed.

NORTH CAROLINA.

Institute directors.—S. L. Patterson, commissioner of agriculture, Raleigh; Tait Butler, professor of veterinary science in North Carolina College of Agriculture and Mechanic Arts; field agent, Raleigh.

A determined effort was made through the farmers' institutes of North Carolina this year in the direction of the improvement of the homes of the country people. This took the form of women's institutes, 21 of which were held in a single month with an average attendance of 83. In starting this work many discouraging circumstances were encountered, chief among which was the spirit of conservatism that led the communities to look upon the women's institute as too great an innovation. Others were the indifference of the women themselves and the difficulty in getting suitable lecturers to address the audiences. At a number of the women's meetings the attendance was extremely small, but taken altogether the experiment was fairly successful and gave encouragement to conduct a similar experiment next year.

The general institutes were well attended, the attendance being 25,950 at 195 sessions, or 133 to each session. About $5,500 was expended in conducting the institutes. This included the salary of the State director and a portion of those members of the agricultural department who aided in the work. The agricultural college and the experiment station contributed twelve men, who gave one hundred and nine days of their time to lecture service. Three independent institutes were held, with a total attendance of 1,000. A round-up farmers' convention, held at Raleigh, continued through eight sessions with an attendance of 400. Thirty thousand copies of institute proceedings are published and distributed to regular mailing lists of the State department of agriculture each year.

OHIO.

Institute director.—T. L. Calvert, secretary State board of agriculture, Columbus.

There was a modification of the institute law in Ohio last year, by which the apportionment of the money raised for institute purposes under the millage tax is appropriated more simply and directly. The old law based the apportionment on the number of inhabitants of each county, as shown by the last census, directing that a sum equal

to 3 mills on each inhabitant of a county be paid to the president of the State board of agriculture and a like sum to the president of the farmers' institute society in the county where but one such society exists, and where two or more exist the amount was to be equally apportioned between them.

The new law fixes the amount to go to the president of the agricultural society at $125 from each county, and $31.25 to the president of each institute society in a county holding meetings under the auspices of the State board. There is a provision that the entire sum shall not exceed $250 for any one county.

Last year 1,225 sessions of institutes were held, with an attendance of 81,816, the largest number of sessions held by any State. The appropriation for institutes was $17,629.89, and the average cost per session was $14.33. Thirty-nine independent institutes were held with an estimated attendance of 13,197. A State institute or round-up meeting, continuing for four sessions, was held, with an attendance of about 500 at each session. A report of the institutes was published, the edition comprising 15,000 copies. The reports were distributed chiefly in the local institute societies.

OKLAHOMA.

Institute director.—C. A. McNabb, secretary of the board of agriculture, Guthrie.

Institutes were held in all but three counties in Oklahoma last year. While there was no direct appropriation by the Territorial legislature for institute expenses, the department of agriculture expended from its appropriation about $500 out of its contingent fund partly for meeting some minor expenses, and the balance was for the salary of the superintendent. The agricultural experiment station also expended about $160 for defraying the expenses of its members in lecturing at the institutes.

The institute work as conducted this season was along much the same lines as in the previous year, except that the lecturers have been giving more attention to the practical side of farming operations particularly as respects seed selection and crop diversification. The stereopticon is being used in illustrating the lectures, also for showing the improvement possible in farm homes and in rural school buildings and surroundings.

In order to secure increased interest in the improvement of their agriculture the plan has been adopted of holding special sessions of institutes about every two weeks. The programmes for these meetings are arranged by a special committee. Each meeting discusses some one subject rather than several, and bulletins and circulars upon that topic are distributed among the members.

One hundred and forty-nine sessions of institutes were held this year, with an attendance of 7,460. Two independent institutes were

held having an estimated attendance of about 1,000. The agricultural experiment station sent out at different times eight men to lecture in the institutes. The aggregate amount of time given by them to this work during the year amounted to sixty-three days.

In assuming the responsibility of statehood Oklahoma has an opportunity for organizing her farmers' institutes upon a comprehensive basis and to enlarge the field of the institutes to embrace the giving of assistance to all agricultural institutions of whatever kind and to the system of public instruction as it affects the rural population by showing how the rural schools may be improved and the education given in them be adapted to meeting the special educational needs of farming people. That portion of the new State known as the Indian Territory which has not had institutes as yet can now be supplied.

OREGON.

Institute director.—James Withycombe, director agricultural experiment station, Corvallis.

Interest in the farmers' institutes in Oregon is increasing each year. In 1903–4 there were held 46 sessions of institutes, with an attendance of 4,500 persons. In 1905–6 there were held 109 sessions of institutes, with an attendance of 16,350 persons. Farming throughout the State has been much improved by the information that the institutes have distributed, exciting greater interest in the results of the work of the experiment station, and increasing the attendance at the Agricultural College.

As a rule two members of the experiment station staff attended each institute. In addition to these there were two specialists, one a successful dairyman and the other a noted breeder of draft horses. During the past season the station men delivered 218 addresses in institute meetings and participated in the discussions. The director has adopted the plan of shortening the addresses and devoting more time to the discussion of the subjects presented. The effect has been to increase the interest of farmers and to bring out more definite and practical information.

Encouragement has been given to the exhibition feature of the institute. Farmers are requested to bring out for exhibition specimens of the products of their farms as object lessons of what can be grown in the several localities. Practical demonstrations of this character have been found to be of great value in encouraging those who have failed in the growing of any crop to try again, applying the additional information which the institute has brought them in conducting the operation.

The stereopticon has been used to considerable extent in the evening meetings chiefly in illustrating the various types of dairy animals.

The State appropriates $2,500 annually for meeting the expenses of the institutes. During the past year a farmers' conference and grange picnic were held in addition to the regular institutes, with an attendance of about 2,500 persons.

PENNSYLVANIA.

Institute director.—A. L. Martin, deputy secretary of agriculture and director of farmers' institutes, Harrisburg.

Institutes were held in Pennsylvania last year in 225 different localities. There were 987 sessions, and an attendance of 165,553 persons. The amount appropriated for institute purposes was $20,500. The average attendance per session was 167. Thirty-one independent institutes were held in addition, with an attendance of 15,000 persons. There was also a round-up institute continuing for eight sessions, with an attendance of 1,000. A butter school continuing for a week was held in one of the dairy districts, conducted by a dairy expert from the dairy department of the agricultural college, under the auspices of the State institute director. The results were highly satisfactory.

For institute purposes the State is divided into six districts, and a corps of institute teachers is assigned to each district, each corps consisting of three lecturers selected and paid by the State director. The institute season extended from the last of November to the first of March, during which period all of the institute force was at work giving instruction. The special topics discussed were soil building, centralized schools, and animal husbandry. The agricultural experiment station furnished two men who were out in the field engaged in lecturing for sixty-two days. A woman's session was held in each institute. In some instances this was presided over by a lady selected by the community, and in others by the institute director. The places at which institutes are to be held are suggested by the local county committees, subject to the approval of the State director, who fixes the dates at which the meetings are to take place and arranges the itinerary in each district.

The proceedings of the annual round-up meeting of the institute workers are published in bulletin form and distributed through the mails and at institute meetings. Some of the best of the papers and addresses before the institutes are selected and published in the annual report of the State department of agriculture, of which 32,500 copies are printed annually.

PORTO RICO.

Institute director.—D. W. May, special agent in charge of the agricultural experiment station, Mayaguez.

One institute was held in Porto Rico last year, and was in connection with the Fruit Growers' Association at Bayamon. This association is composed of planters from the States, most of whom are

intelligent and enterprising agriculturists. The special agent who has been in charge of the institutes has found it most effective in the present state of agriculture in the island to visit periodically the different plantations and give demonstrations in the use of fertilizers, the mixing of sprays, spraying orchards, and in the laying out of farms, etc.

RHODE ISLAND.

Institute director.—John H. Dunn, secretary State board of agriculture, Providence.

One institute was held in Rhode Island this year under the auspices of the Rhode Island Conference of Rural Progress, to which the State board of agriculture appropriated $100 for aiding in defraying the expense of the meeting. There is no special appropriation for institute purposes in Rhode Island. Whatever is devoted to this purpose is taken from the general funds appropriated to the board of agriculture. The attendance at the joint institute referred to was about 300.

The law directs that the board of agriculture shall hold at least one agricultural institute in each county each year, and may hold as many more as it deems expedient. The secretary of the State board of agriculture is charged with the duty of arranging for the holding of institutes and the cost is to be met out of the $15,000 annually appropriated for the expenses of the board.

SOUTH CAROLINA.

Institute director.—J. N. Harper, director agricultural experiment station, Clemson College.

Authority to hold farmers' institutes in South Carolina is given by act of assembly to the board of trustees of the Clemson Agricultural College. The general management of the work is placed by the board in the hands of the director of the agricultural experiment station. Last year 74 sessions of institutes were held with an attendance of 11,149, and at a cost of $2,325.83. This does not include the salary of the institute director. The appropriation for 1907 is $5,000. The faculty of the agricultural college and the members of the experiment station staff contributed fifty-four days of time to the work. A round-up institute attended by about 1,000 persons and continuing for eight sessions was held. The Southern Railway aided the college in its institutes by giving the use of two cars for the transportation of illustrative material, and hauled these cars from place to place free of cost to the college. The institutes were all of one-day duration, and usually consisted of two sessions. The director selects the dates at which the institutes are to be held, and the place is designated by the institute board of trustees of the college upon invitations signed by at least 15 persons in the locality desiring an institute.

SOUTH DAKOTA.

Institute director.—A. E. Chamberlain, superintendent of farmers' institutes, Brookings.

The legislature of South Dakota by act approved March 3, 1905, created a State Farmers' Institute Board composed of the president of the agricultural college and two members of the State board of regents, and appropriated $5,000 per year for institute purposes. One hundred and nineteen sessions of institutes were held last year with an attendance of about 10,000 persons. The agricultural college and the experiment station furnished together seven men for institute service who gave about sixty days of time to the work. An independent institute was held with an attendance of about 300. There was also one session of institute specially for boys with excellent results. About one hundred young people between the ages of 15 and 21 participated. The time was given chiefly to giving instruction in corn and stock judging. Dairy cattle, beef animals, sheep, and swine were provided by the community for this purpose. Prizes were given, running as high as $5 in one instance. The judging of cereals extended to grains other than corn, embracing all of the crops that are usually grown upon a farm. The evening sessions were largely devoted to literary programmes along lines in the direction of beautifying and adding to the convenience of farm homes. Lectures on general subjects were also introduced, and good music both instrumental and vocal was made a feature. In one locality the institute continued for an entire week with constantly increasing interest. The weather conditions were such at times as to seriously interfere with the work, the extreme cold making it impossible in some instances for holding meetings through inability to heat the halls.

The institutes are now well started in South Dakota, and the coming year will no doubt see the work organized in all of the counties with efficient local committees in charge. The law provides that in all counties wherein is held a farmers' institute, organized by the election of five directors from whom shall be selected a president, vice-president, and secretary-treasurer, the institute shall be entitled to a sum not exceeding $200 annually to be paid by the county commissioners and upon the presentation of regularly certified bills. This provision for meeting the expenses of the institutes in addition to the one appropriating $5,000 to the agricultural college for institute purposes will enable the work in South Dakota to be carried on successfully, and to reach all portions of the State.

TENNESSEE.

Institute director.—W. W. Ogilvie, commissioner of agriculture, Nashville.

The agriculture of Tennessee is marked by three distinct divisions of territory known as eastern, middle, and western Tennessee. The principal crops grown on these areas are quite distinct, making it necessary to adapt the institutes to the several sections in order to meet their special requirements. This has made the work of conducting the institutes much more difficult than exists in some other States where the agricultural crops are more nearly homogeneous. During the past year 35 institutes were held; 5 one-day, 27 two-days, and 3 three or more days, aggregating 68 sessions, and having an attendance of 6,000. The amount appropriated for the institutes was $2,500. Three round-up institutes or farmers' conventions were held, one in each of the sections referred to. They were attended by 4,000 persons and each continued through 8 sessions. The commissioner of agriculture fixes the dates and places for all of the meetings and also selects the State lecturers and arranges the programmes. Notice of the dates and places is given through the newspapers and by circulars sent directly to individuals. An annual report of the institute work is published, the edition numbering 5,000 copies which are distributed for the most part by mail.

TEXAS.

Institute director.—J. W. Carson, acting director agricultural experiment station, College Station.

The last legislature failed to make an appropriation for the support of the institute work in Texas. The board of trustees of the Agricultural and Mechanical College, appreciating the value of the work and not wishing to see it discontinued, made an appropriation from college funds to the amount of $540 to pay part of the salary of the director of institutes, the balance of which was supplied out of the fund appropriated by the National Government for meeting the expense connected with the conducting of diversified farms throughout the State, the director of institutes being also charged with the oversight of these farms. Under this arrangement 27 institutes were held, consisting of 35 sessions and attended by 4,500 persons. A round-up institute attended by about 1,000 persons, was held, continuing through four sessions. Local farmers' institutes, picnics, farmers' union meetings, etc., were held throughout the State with an estimated attendance of 50,000. The results are seen in the enthusiasm aroused and in the general introduction of the improved methods in farming advocated by the institute lecturers. The agricultural college is asking the legislature for an appropriation of $10,000 for the next two years for institute purposes. If this is secured, a

large amount of work can be accomplished, particularly if this amount is supplemented by the support which the National Government is giving in its propaganda of diversified farming in southern agriculture.

UTAH.

Institute director.—P. A. Yoder, director agricultural experiment station, Logan.

By act of the legislature institutes are required to be held in each county in Utah each year. For meeting the expenses of this work $1,500 annually is appropriated to the trustees of the agricultural college, who are charged with the carrying out of the provisions of this act. Last year 45 institutes were held, made up of 73 sessions, with an average attendance of 91 persons per session, or a total of 6,680. A special effort was made to organize the farmers in each community into institutes or clubs and then to effect a county organization of which the local societies will be the units. Ultimately it is expected to form a State organization in which the county organizations, and through them all of the local organizations will be represented. The presidents of the local societies are vice-presidents of the county organizations, and from their number a president of the county organizations is chosen. The general work is under the control of the institute committee of the agricultural college faculty, who have appointed as their executive officer in the institutes the director of the agricultural experiment station. It is the aim of this committee to send speakers to one or more meetings of the county organizations each year, and to as many of the local organizations as possible. The responsibility for advertising meetings and for arranging the details of the programmes is left with the officers of the county and local organizations.

The work of the past year differs from that of previous years in that the lecture work was distributed through the entire faculty of the college and the staff of the experiment station. Fifteen members of the college faculty participated in the institute work, contributing two hundred and sixty hours, and eleven members of the station staff contributed one hundred and eighty hours, or fifty-five days of eight hours each in all. The general county meetings followed those held in the smaller settlements of the county as a round-up of the work in that county for that year.

VERMONT.

Institute director.—George Aitken, secretary State board of agriculture, Woodstock.

The board of agriculture of Vermont is required to hold one meeting in each county annually. The purposes of the board are declared to be "for the improvement of the general interests of husbandry and the promotion of agricultural education throughout the State."

The annual appropriation for farmers' meetings or institutes is $5,000. Thirty-eight institutes were held last year, consisting of 76 sessions, with a total attendance of 7,962 persons. A "better farming special" was run for one week. During this time it made fifty-one stops. The cars were crowded at every station. The estimated number in attendance upon this train during this trip was 10,000. The experiment station furnished four lecturers for the institutes who gave thirty-one days to the work. A report of the institutes is prepared each year by the secretary and 3,000 copies are printed and distributed.

VIRGINIA.

Institute directors.—G. W. Koiner, commissioner of agriculture, Richmond; A. M. Soule, director agricultural experiment station and secretary Virginia State Farmers' Institute, Blacksburg.

Farmers institutes in Virginia are under the direction of the State board of agriculture which is composed of a representative from each of the ten Congressional districts. Five hundred dollars is appropriated annually for institutes in each district, and is expended under the direction of the representative of the board of the district. The only part of the work made the official duty of the secretary of the board is to receive the reports of these members and prepare them for publication. He has no fund to use for institute purposes outside of the appropriation to the directors, and consequently has no money to draw upon for the payment of speakers or other expenses.

Three years ago there was organized at Roanoke, Va., the Virginia State Farmers' Institute. This body is composed of representative farmers from all parts of the State who meet in a general convention once a year and discuss the needs of agriculture, and visit the agricultural college and experiment station at Blacksburg. The attendance this year was about 1,200, of whom 1,050 visited the college at Blacksburg on a special train provided by the Norfolk and Western Railway. The institute has a regular membership of about 600. Fifty-five of the counties of the State are represented upon it by county vice-presidents who are all members of the association. The director of the agricultural experiment station is the secretary of the institute.

During the year there was sent out a special seed train through a portion of the tobacco region of the State, and also through the Piedmont section and the Shenandoah Valley as well. Stops of thirty minutes were made at each station where meetings had been advertised. About 8,000 farmers were reached in this way. There were 35 regular institute meetings held during the year, composed of 65 sessions attended as reported by the institute director by 19,500 persons,

WASHINGTON.

Institute directors.—E. A. Bryan, president State College of Washington, Pullman; E. E. Elliott, professor of agriculture, State College, field agent in charge of institutes, Pullman.

Owing to the fact that there was no appropriation made for institutes in Washington, none were held under State direction. Thirty-two special or independent institutes, however, were held with an estimated attendance of 2,850. The expense was met by the localities holding the meetings, except that $230 was contributed by the agricultural college. An effort will be made during the coming year to secure an appropriation from the legislature that will reestablish the institute work upon a more efficient system than heretofore.

WEST VIRGINIA.

Institute director.—H. E. Williams, director farmers' institutes, Charleston.

Institutes were held last year in West Virginia in 45 counties. The whole number of institutes was 81, consisting of 224 sessions, and attended by 4,480 persons, held at a cost of $3,966.12. The work is under the control of a State director, who is appointed by the State board of agriculture. The board is required to "hold farmers' institutes for the instruction of the farmers of the State in the various branches of agriculture." Through its agent or director of institutes it fixes the dates and places at which institutes are to be held, and he is held responsible for the progress and efficiency of the work. The instruction given must be, as the law declares, "so arranged as to present to those in attendance the results of the most recent investigations in theoretical and practical farming." A dairy school lasting one week was held in Monroe County with marked success. This is an attempt to increase the informational value of the institutes by devoting more time to giving instruction upon a single topic. The proceedings of the institutes are distributed through the Farm Review, a paper published by the State in its department of agriculture.

The difficulties of transportation in West Virginia interfere very seriously with the attendance at the institute meetings. The mountainous character of the country and the sparsely settled condition of much of the State prevent the holding of as large meetings as in other more densely populated and highly developed agricultural regions, so that the average attendance of twenty at each session during the past year signifies much more interest in agriculture than the numbers would seem to indicate.

WISCONSIN.

Institute director.—George McKerrow, director farmers' institutes, Madison.

No new work, strictly speaking, was undertaken in Wisconsin in its institutes during the year. Attention was given to perfecting that which had previously been inaugurated, such as dairying, the breeding of dairy cows, the feeding of cows, sanitation in farm stables, ventilation, milk testing, cooperative creameries, cheese-making, horse breeding, feeding and developing horses for the market, sheep husbandry, swine breeding and fattening, poultry rearing, including egg production, farm gardening, small fruits, orchards, and other horticultural crops, together with giving information in the growing of the various other farm crops that are adapted to Wisconsin soil and climate.

Two hundred and forty-three sessions of institutes were held, with an attendance of 32,200. At least one institute was held in each county of the State. The annual appropriation is $12,000, to which there was added $972 for advertising space in the institute annual last year. A round-up institute was held, continuing through 11 sessions, with an attendance of 4,875. A railway special was run, but inasmuch as this was not under institute direction, the results are not reported. A feature of the Wisconsin institutes is the publication of the Institute Annual of 320 pages—a handbook of practical agriculture. This is prepared annually and 60,000 copies are published and distributed. It is intended in this way to preserve in permanent form the most valuable papers, lectures, and discussions that have been presented before the institutes during the year. The institute work in Wisconsin is under the control of the board of regents of the State University who appoint a director to take immediate charge of the work.

WYOMING.

Institute director.—B. C. Buffum, director agricultural experiment station, Laramie.

The director of institutes for Wyoming held last year 11 meetings, composed of 64 sessions, having an attendance of 3,401 persons. The amount of time and labor which this involved can not be appreciated except by those who are familiar with the conditions that exist in Wyoming. The sparsely settled state of the country, the lack of railroad facilities, and the severity of the climate combine to add to the difficulty of reaching all portions of the State with institute instruction. The work was performed chiefly by the members of the faculty of the agricultural college and by the experiment station staff. The college contributed three men for ten days, and the station five men for one hundred and fifteen days. Considering the difficulties and the small appropriation, $1,000 per year, the amount of work done is surprising.

STATISTICS OF FARMERS' INSTITUTES, 1906.

Number of institutes held and the approximate attendance during the year ended June 30, 1906.

State or Territory.	Number of one-day institutes.	Number of two-day institutes.	Number of three or more day institutes.	Total.	Total number of sessions.	Total attendance at all sessions.	Average per session.
Alabama	27	8		35	85	8,590	101
Alaska [a]							
Arizona	21			21	21	1,307	62
Arkansas	28	3		31	42	7,150	170
California	55	27	1	83	272	22,861	84
Colorado	24	13	3	40	123	16,675	135
Connecticut	24			24	83	4,895	59
Delaware	18			18	40	7,200	180
Florida [a]							
Georgia	17	4		21	42	4,500	107
Hawaii	4			4	8	300	37
Idaho	5	15	1	21	105	7,875	75
Illinois		65	43	108	667	79,428	119
Indiana	118	132		250	918	129,894	141
Iowa		36	33	69	402	66,959	166
Kansas	128	25	2	155	522	27,300	52
Kentucky	1	24		25	122		
Louisiana	22			22	44	2,657	60
Maine	50			50	102	6,967	68
Maryland	37	12		49	125	10,762	86
Massachusetts	125			125	153	19,125	125
Michigan	259	72	4	335	934	122,573	128
Minnesota	98	5	2	105	238	51,211	215
Mississippi	108	2		110	220	10,000	45
Missouri	100	55	1	156	410	36,900	90
Montana	64	7		71	133	7,890	59
Nebraska	71	86	3	160	515	72,894	141
Nevada [a]							
New Hampshire	15	1		16	34	3,000	88
New Jersey	33	7		40	116	11,611	100
New Mexico [a]							
New York	114	142	3	259	1,062	134,989	126
North Carolina	95	1		96	195	25,950	133
North Dakota	17	21	5	43	162	20,310	125
Ohio		245		245	1,225	81,816	66
Oklahoma	2	29		31	149	7,460	50
Oregon	40	4		44	109	16,350	150
Pennsylvania	63	159	4	226	987	165,553	167
Porto Rico	1			1	1	50	50
Rhode Island		1		1	2	300	150
South Carolina	54			54	74	11,149	150
South Dakota	17	40	2	59	119	10,000	84
Tennessee	5	27	3	35	68	6,000	88
Texas	25	2		27	35	4,500	128
Utah	40	5		45	73	6,680	91
Vermont	38			38	76	7,960	104
Virginia					65	19,500	300
Washington [a]							
West Virginia	50	31		81	224	4,480	20
Wisconsin	81			81	243	32,200	132
Wyoming	4	5	2	11	64	3,401	53
Total	2,098	1,311	112	3,521	11,409	1,299,172	4,860
Average							[b] 114

[a] No institutes held.
[b] Obtained by dividing total attendance by total number of sessions.

Financial statistics of the farmers' institutes for the year ended June 30, 1906.

State or Territory.	Funds appropriated.		Cost.		Appropriations for the season of 1906-7.
	State.	College and other funds	Total cost.	Cost per session.	
Alabama		$600.00	[b] $600.00	$7.06	$600.00
Alaska [a]					
Arizona	$608.85		608.85	28.99	
Arkansas	250.00	150.00	[b] 400.00	9.52	
California	6,000.00	3,000.00	[b] 9,000.00	33.08	6,000.00
Colorado	4,000.00		3,300.00	26.83	
Connecticut	400.00	1,425.00	1,825.00	22.00	
Delaware	600.00	125.00	[b] 725.00	18.12	600.00
Florida [a]					
Georgia	2,500.00		2,500.00	59.52	2,500.00
Hawaii		33.45	[b] 33.45	4.18	
Idaho	1,000.00		[b] 1,000.00	9.52	1,000.00
Illinois	17,150.00	13,131.55	29,669.56	44.48	17,150.00
Indiana	10,000.00	2,500.00	12,500.00	13.61	10,000.00
Iowa	7,425.00	671.06	[b] 8,096.06	20.14	7,425.00
Kansas	2,000.00		[b] 2,000.00	3.83	2,500.00
Kentucky	1,750.00		[b] 1,750.00	14.23	15,000.00
Louisiana	2,000.00		[b] 2,000.00	45.45	2,000.00
Maine	5,000.00		5,000.00	49.02	5,000.00
Maryland	6,000.00		4,000.00	32.00	6,000.00
Massachusetts	3,000.00		[b] 1,760.44	11.51	3,000.00
Michigan	7,500.00	7,500.00	15,000.00	16.06	7,500.00
Minnesota	18,000.00	2,238.40	20,200.00	84.87	18,000.00
Mississippi	3,000.00		[b] 3,000.00	13.64	3,000.00
Missouri	5,000.00		5,000.00	12.20	
Montana	4,000.00	1,000.00	[b] 4,926.54	37.04	4,000.00
Nebraska	6,000.00	2,607.00	8,607.00	16.71	6,000.00
Nevada [a]					
New Hampshire	1,600.00	500.00	[b] 2,100.00	61.76	1,600.00
New Jersey	3,000.00		3,000.00	25.86	3,000.00
New Mexico [a]					
New York	20,000.00		20,000.00	18.83	20,000.00
North Carolina	2,500.00	3,000.00	5,500.00	28.21	3,500.00
North Dakota	6,000.00	379.07	5,577.16	34.43	6,000.00
Ohio	16,747.62	882.27	[b] 17,629.89	14.33	22,000.00
Oklahoma	500.00	160.00	660.00	4.43	
Oregon	2,500.00		1,724.73	15.82	2,500.00
Pennsylvania	20,500.00		20,500.00	20.77	20,500.00
Porto Rico					
Rhode Island	100.00		[b] 100.00	50.00	
South Carolina	4,524.40		[b] 2,325.83	31.43	5,000.00
South Dakota	5,000.00	1,500.00	6,500.00	54.62	5,000.00
Tennessee	2,500.00		2,426.11	35.68	2,500.00
Texas		540.00	540.00	15.43	
Utah	1,500.00	500.00	2,000.00	27.40	1,500.00
Vermont	5,000.00		2,830.34	37.24	
Virginia	5,000.00		[b] 5,000.00	76.00	5,000.00
Washington [a]					
West Virginia	3,966.12		3,966.12	17.70	4,000.00
Wisconsin	12,000.00		10,782.74	44.37	12,000.00
Wyoming	1,000.00	107.59	[b] 1,107.59	17.31	1,000.00
Total	227,121.99	42,550.39	257,772.41	1,265.23	232,375.00
Average				28.12	

[a] No institutes held.
[b] Salary of directors and college and station speakers not included.

Comparative statement of farmers' institutes—appropriations, number, attendance.

State or Territory.	Appropriations.			Number of sessions.		Number of institutes.			Attendance.		
	1903–4	1904–5	1905–6	1904–5	1905–6	1903–4	1904–5	1905–6	1903–4	1904–5	1905–6
Alabama	$600.00	$600.00	$600.00	48	85	24	24	35	3,639	3,820	8,590
Alaska [a]	......	......	......	......	......	......	......	......	......	......	......
Arizona	50.00	50.00	608.85	12	21	1	1	21	600	250	1,307
Arkansas	......	400.00	400.00	60	42	......	30	31	......	7,650	7,150
California	7,234.00	8,934.00	9,000.00	429	272	113	110	83	43,680	43,494	22,861
Colorado	517.00	......	4,000.00	52	123	15	20	40	1,660	2,700	16,675
Connecticut	200.00	428.00	1,825.00	28	83	18	14	24	2,500	1,200	4,895
Delaware	750.00	750.00	725.00	23	40	18	18	18	3,436	4,199	7,200
Florida [a]	......	......	......	......	......	......	......	......	......	......	......
Georgia	1,000.00	3,500.00	2,500.00	108	42	34	44	21	7,000	18,000	4,500
Hawaii	30.00	35.00	33.45	8	8	4	4	4	200	350	300
Idaho	1,000.00	1,000.00	1,000.00	113	105	17	25	21	3,100	4,000	7,875
Illinois	18,173.00	20,960.39	30,281.55	635	667	105	100	108	84,681	69,759	79,428
Indiana	10,000.00	10,000.00	12,500.00	883	918	175	250	250	59,189	79,964	129,894
Iowa	7,425.00	7,425.00	8,096.06	207	402	70	60	69	17,750	18,000	66,959
Kansas	2,000.00	2,000.00	2,000.00	144	522	58	55	155	14,432	11,455	27,300
Kentucky	500.00	1,206.16	1,750.00	73	122	4	17	25	1,200	3,350	......
Louisiana	2,000.00	2,500.00	2,000.00	208	44	39	67	22	12,000	14,541	2,657
Maine	2,500.00	5,000.00	5,000.00	93	102	37	44	50	5,473	5,731	6,967
Maryland	4,000.00	6,000.00	6,000.00	73	125	23	26	49	3,250	5,741	......
Massachusetts	1,530.00	2,700.00	3,000.00	167	153	104	115	125	11,039	12,372	19,125
Michigan	9,825.00	9,300.00	15,000.00	827	934	292	270	335	52,236	55,004	122,573
Minnesota	18,000.00	18,000.00	20,238.40	227	238	154	105	105	46,210	52,125	51,211
Mississippi	1,725.00	3,000.00	3,000.00	311	220	107	153	110	11,326	30,000	10,000
Missouri	5,000.00	3,100.00	5,000.00	256	410	147	104	156	30,220	2,560	36,900
Montana	4,000.00	2,500.00	5,000.00	100	133	44	47	71	4,500	6,946	7,890
Nebraska	6,000.00	6,000.00	8,607.00	480	515	96	150	160	25,097	67,241	72,894
Nevada	83.00	379.00	(a)	20	......	4	10	......	453	665	......
New Hampshire	1,588.00	1,600.00	2,100.00	28	34	18	13	16	3,400	2,900	3,000
New Jersey	1,800.00	1,838.15	3,000.00	111	116	30	30	40	4,500	5,538	11,611
New Mexico	28.00	28.00	(a)	3	......	4	1	......	150	150	......
New York	20,000.00	20,000.00	20,000.00	967	1,062	267	261	259	64,347	87,439	134,989
North Carolina	850.00	2,150.00	5,500.00	226	195	35	61	96	8,411	11,168	25,950
North Dakota	4,000.00	4,171.94	6,379.07	140	162	46	61	43	13,567	12,838	20,310
Ohio	16,747.00	19,598.68	17,629.89	1,399	1,225	245	281	245	75,360	92,593	81,816
Oklahoma	1,000.00	......	660.00	156	149	52	58	31	5,200	5,500	7,460
Oregon	350.00	620.00	2,500.00	54	109	14	18	44	4,500	5,500	16,350
Pennsylvania	20,500.00	20,500.00	20,500.00	862	987	204	196	226	70,380	150,932	165,553
Porto Rico	......	......	......	......	1	......	......	1	......	......	50
Rhode Island	600.00	100.00	100.00	6	2	12	1	1	1,260	400	300
South Carolina	600.00	1,194.56	4,524.40	56	74	33	33	54	8,690	7,460	11,149
South Dakota	(a)	(a)	6,500.00	(a)	119	(a)	(a)	59	(a)	(a)	10,000
Tennessee	5,000.00	5,000.00	2,500.00	200	68	72	72	35	8,300	8,300	6,000
Texas	3,950.00	3,850.00	540.00	146	35	144	110	27	15,130	8,500	4,500
Utah	1,500.00	1,500.00	2,000.00	40	73	59	15	45	12,000	1,500	6,680
Vermont	5,000.00	5,000.00	5,000.00	80	76	48	40	38	10,000	7,500	7,962
Virginia	3,500.00	5,500.00	5,000.00	70	65	50	35	......	10,000	8,000	19,500
Washington	2,500.00	3,000.00	(a)	150	(a)	57	46	......	15,922	7,282	......
West Virginia	4,556.00	2,455.26	3,966.12	199	224	97	63	81	12,095	9,450	4,480
Wisconsin	12,000.00	14,942.75	12,000.00	270	243	101	82	81	52,000	43,000	32,200
Wyoming	......	......	1,107.59	7	64	......	1	11	......	75	3,401
Total	210,211.00	225,738.89	269,672.38	10,555	11,409	3,306	3,271	3,521	841,648	995,192	1,299,172

[a] No institutes held.

Number of lecturers employed by the State directors of farmers' institutes during the year ended June 30, 1906.

State or Territory.	Total number of lecturers on the State force.	Number of members of agricultural college and experiment station staffs engaged in institute work.	Number of days contributed to institute work by the agricultural college and experiment station staffs.	Total number of days of institutes held during the year.	Reports of proceedings.	
					Published.	Number of copies.
Alabama	13	8	150	43	No	
Alaska [a]						
Arizona	3	3	21	21	No	
Arkansas	6	6	31	34	No	
California	37	10	100	112	Yes	12,500
Colorado	23	12	295	53	Yes	10,000
Connecticut	60	11	40	24	No	
Delaware	11	1	12	18	Yes	5,000
Florida [a]						
Georgia	34	6	106	25	No	
Hawaii	9	4	8	4	Yes	1,000
Idaho	13	9	20	38	No	
Illinois	109	30	239	259	Yes	20,000
Indiana	46	5	27	382	No	
Iowa	5			171		
Kansas	21	21		184	No	
Kentucky				49		
Louisiana	20	2		22	Yes	2,500
Maine	27	2	20	50		
Maryland	8			61		
Massachusetts	69	13	13	125	Yes	15,000
Michigan	42	13	100	415	Yes	9,500
Minnesota	105	4	18	114	Yes	3,500
Mississippi	21	18	360	112	No	
Missouri	28	14		213	In part	
Montana	25	8	110	78	Yes	5,000
Nebraska	38	15	150	252	No	
Nevada [a]						
New Hampshire	12	8	8	17	Yes	2,000
New Jersey	14	4	66	47	No	
New Mexico [a]						
New York	64	22	230	407	Yes	15,000
North Carolina	21	12	109	97	Yes	30,000
North Dakota	47	4	35	74	Yes	10,000
Ohio	27			490	Yes	15,000
Oklahoma	9	8	63	60	No	
Oregon	8	4	220	48	No	
Pennsylvania	56	2	62	393	Yes	50,000
Porto Rico	3	1	1	1	No	
Rhode Island	4			2	Yes	2,000
South Carolina	15	15	108	54	No	
South Dakota	14	14	120	103	Yes	600
Tennessee	11	4		68	Yes	5,000
Texas	39	2	2	29	No	
Utah	17	17	55	50	Yes	7,000
Vermont	26	8		38	Yes	3,000
Virginia	11					
Washington [a]						
West Virginia	29	1	220	112	Yes	
Wisconsin	24	0		81	Yes	60,000
Wyoming	1	1		26	No	
Total	1,225	342	3,119	5,056		315,100

[a] No institutes held.

Population of the several States and Territories in 1900, the total number of homes, the number and per cent of farm homes, and the approximate population in farm homes.

State or Territory.	Population.	Total number of homes.	Number of farm homes.	Per cent of farm homes.	Approximate population in farm homes.
Alabama	1,828,697	374,765	217,461	58	1,060,644
Alaska	63,592	13,459	27	0.2	127
Arizona	122,931	29,875	7,391	24.7	30,362
Arkansas	1,311,564	265,238	176,017	66.4	870,878
California	1,485,053	341,781	71,119	20.8	308,891
Colorado	539,700	127,459	24,745	19.4	104,701
Connecticut	908,420	203,424	26,609	13.1	119,003
Delaware	184,735	39,446	9,677	24.5	45,260
Florida	528,542	117,001	40,965	35	184,989
Georgia	2,216,331	455,557	221,395	48.6	1,077,138
Hawaii	154,001	36,922	1,409	3.8	5,852
Idaho	161,772	37,491	17,153	45.8	74,091
Illinois	4,821,550	1,036,158	262,388	25.3	1,219,852
Indiana	2,516,462	571,513	221,451	38.7	973,870
Indian Territory	392,060	76,701	47,594	62.1	187,579
Iowa	2,231,853	480,878	223,525	46.5	1,037,811
Kansas	1,470,495	321,947	167,006	51.9	763,186
Kentucky	2,147,174	437,054	234,821	53.7	1,153,032
Louisiana	1,381,625	284,875	114,214	40.1	554,031
Maine	694,466	163,344	57,153	35	243,063
Maryland	1,188,044	242,331	47,089	19.4	230,480
Massachusetts	2,805,346	613,659	36,510	5.9	165,515
Michigan	2,420,982	548,094	202,457	36.9	893,342
Minnesota	1,751,394	342,658	152,393	44.5	779,470
Mississippi	1,551,270	318,948	221,110	69.3	1,075,030
Missouri	3,106,665	654,333	282,840	43.2	1,340,079
Montana	243,329	55,889	13,909	24.9	60,588
Nebraska	1,066,300	220,947	116,854	52.9	564,072
Nevada	42,335	11,190	2,164	19.3	8,170
New Hampshire	411,588	97,902	28,271	28.9	118,948
New Jersey	1,883,669	415,222	35,337	8.5	160,111
New Mexico	195,310	46,355	13,102	28.3	55,272
New York	7,268,894	1,634,523	227,822	13.9	1,010,376
North Carolina	1,893,810	370,072	223,831	60.5	1,145,755
North Dakota	319,146	64,690	44,112	68.2	217,657
Ohio	4,157,545	944,433	280,068	29.7	1,237,790
Oklahoma	398,331	86,908	63,094	72.6	289,188
Oregon	413,536	91,214	36,156	39.6	163,761
Pennsylvania	6,302,115	1,320,025	225,565	17.1	1,077,660
Porto Rico					
Rhode Island	428,556	94,179	5,638	6	25,713
South Carolina	1,340,316	269,864	152,993	56.7	759,959
South Dakota	401,570	83,536	51,937	62.2	249,776
Tennessee	2,020,616	402,536	226,027	56.2	1,135,585
Texas	3,048,710	589,291	341,889	58	1,768,251
Utah	276,749	56,196	19,529	34.8	96,308
Vermont	343,641	81,462	32,871	40.4	138,830
Virginia	1,854,184	364,517	170,412	46.8	867,758
Washington	518,103	113,086	33,931	30	155,430
West Virginia	958,800	186,291	94,566	50.8	487,070
Wisconsin	2,069,042	436,063	169,531	39.8	823,478
Wyoming	92,531	20,116	5,939	29.5	27,296
Total	75,933,450	16,191,418	5,700,067	1,908.4	26,143,078
Average				37.4	

THE NUTRITION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS AND THEIR RESULTS.

By C. F. Langworthy,
In charge of Nutrition Investigations.

In recent years the experimental study of various problems connected with food and nutrition of man and domestic animals has been actively followed in the United States. Some of the work has been of a very practical nature and some has been highly technical. Though they are not commonly considered together, the studies of the food of man and animals have much in common, for of course the physiological laws which underlie the nutrition of the animal body are essentially the same for all warm-blooded animals. Then, too, many experimental methods are common to both classes of investigation, at least as regards the principles on which they are based, though it is needless to say that the details and the manner of using the methods are varied. A considerable part of this inquiry into the various food problems has been carried on in connection with the agricultural experiment stations which have been established in the United States during the last thirty years and are now in operation in all the States and Territories of the Union with the exception of the Philippines. In the earlier years of the experiment station movement in this country investigations which had to do with food in a broad sense were quite largely confined to work with domestic animals. However, early in their history many of the experiment stations studied the nutritive value of grains and other foods used by man as well as various problems connected with the storage, handling, and transportation of food products and related questions, and after a time a number of them included studies of the food of man in their regular work.

Studies of the nutritive value of different foods have been conducted in the United States for a great many years, but the first systematic attempt to investigate such problems dates from the investigations carried on by Prof. W. O. Atwater for the Smithsonian Institution and for the Massachusetts bureau of labor and statistics, and the nutrition investigations of the Office of Experiment Stations are a natural outgrowth of this enterprise, as Professor Atwater, who was the first director of the Office of Experiment Stations, early sought to include this work with the other lines followed.

In 1894–5 Congress provided a special appropriation which enabled the Secretary of Agriculture to prosecute inquiries in this direction and

the work was later assigned to the Office of Experiment Stations. From the first the plan of cooperation with experiment stations, agricultural colleges, and other educational institutions and with philanthropic associations was followed in the belief that such a course, in which each party was a contributor, would yield the most satisfactory returns for a given investment. The sums which have been appropriated by Congress for the nutrition investigations of the Department of Agriculture have been since the beginning as follows:

Appropriations for nutrition investigations.

Fiscal year.	Amount.	Fiscal year.	Amount.
1894–95	$10,000	1901–2	$20,000
1895–96	15,000	1902–3	20,000
1896–97	15,000	1903–4	20,000
1897–98	15,000	1904–5	20,000
1898–99	15,000	1905–6	20,000
1899–1900	15,000	1906–7	20,000
1900–1901	17,500		

These amounts have been increased by contributions from other sources, some of which are not easily estimated in terms of money, since they consist in large part of the use of laboratories, apparatus, chemicals, and other facilities for research, the counsel and help of experts, and similar services. Some of the States, notably Connecticut and Illinois, have made special appropriations for the study of problems relating to the food and nutrition of man, and a considerable number of the experiment stations, educational institutions, philanthropic associations, and private individuals have donated sums of money to promote cooperative research.

Until ill health prevented, Prof. W. O. Atwater was the chief of the nutrition investigations and was responsible for the plans and general oversight of the work. A large amount of experimental work was also carried on under his immediate supervision in Professor Atwater's laboratory in the chemical department of Wesleyan University, the Connecticut (Storrs) Experiment Station being a generous contributor to the enterprise. As time progressed and the correspondence and other business arrangements connected with the nutrition investigations developed, it became evident that the enterprise as a whole should be centered in Washington, and at the beginning of the fiscal year 1906–7 a division of nutrition investigations was established in the Office of Experiment Stations.

SCOPE OF THE WORK.

In the earlier years of the nutrition investigations many analyses of American food materials were made, as the data regarding the chemical composition of such food materials were comparatively limited. Information along this line has, however, accumulated very rapidly

as a result of studies carried on by different investigators, and data are now so abundant that studies of proximate composition of food materials no longer constitute one of the lines of work followed in the cooperative nutrition investigations of the Office. Dietary studies—that is, studies of the kinds and amount of food purchased, eaten, and wasted—were early recognized as of great importance, and a large number have been made in private families, schools, colleges, public institutions, and elsewhere under a variety of conditions and in widely separated regions.

No matter what its composition, food is of no use to the body unless it is digested, and it is natural that experiments should have been undertaken with a variety of food materials to learn how thoroughly they were assimilated by the body and to ascertain the effect of various methods of preparation and combination upon thoroughness of digestion. Furthermore, it is supposable that the occupation in which the subject is engaged, whether active or sedentary, may have an influence upon the work of the digestive tract, and this question has also been studied. Many questions regarding the thoroughness of assimilation may be investigated with the aid of ferments under conditions which approximate those in the body, and a large number of such artificial digestion experiments have been carried on, particularly in studying ease and rapidity of digestion, a question which is very different from thoroughness of digestion, though the two are often confused in popular discussions of the subject.

Variations in the excretion of nitrogen have long been regarded as indications of changes taking place in the body, and it has been a general custom of physiologists to study the balance of income and outgo of nitrogen. Such studies have formed a part of the nutrition investigations of the Department. Much more useful as a means of studying the food requirements of the body and other questions are determinations of the balance of carbon, oxygen, and hydrogen, as well as nitrogen, and determinations of the balance of income and outgo of energy. Such studies necessitate special apparatus, and a respiration calorimeter has been devised which is admirably adapted to the purpose for which it is designed and which, it seems fair to say, is so far the most perfect instrument of its type. The respiration calorimeter is of such a size that a man may remain in comparative comfort in the respiration chamber for a number of hours or days, and the measurements of income and outgo of matter and energy may be made with great accuracy. The determination of energy values of food and excretory products necessitates some special apparatus for measuring the heat of combustion of these materials, and in connection with the nutrition investigations a bomb calorimeter has been perfected which has proved very satisfactory.

Numerous studies have been undertaken of the changes brought about and losses sustained when foods of different sorts are cooked in different ways, the principal food materials included in this work being bread, vegetables, and meat. Canning and preserving fruits and vegetables may be regarded as special applications of cooking processes and much experimental work has been done along these lines with a view to the elaboration of satisfactory household methods. In general, it may be said that in connection with the different lines of work mentioned it has been necessary to devise and perfect experimental methods, as at the time the investigations were first undertaken the amount of work which had been done in the United States and elsewhere along similar lines was not very considerable.

The same period which has witnessed the development of the nutrition enterprise has seen a great interest aroused in the teaching of home economics in schools and colleges, and nutrition is one of the main divisions included in this subject. As the nutrition investigations have supplied a great deal of data which the teachers of home economics must use and as the Office was already closely identified with other educational enterprises, it was almost inevitable that the pedagogics of nutrition should receive attention and become an increasingly important part of the nutrition enterprise.

The preparation of reports of investigations and popular summaries has also constituted an important feature of the work.

The following table shows in graphic form the character and extent of the investigations which have been undertaken up to July 1, 1906:

Cooperative nutrition investigations of the Office of Experiment Stations.

Line of work.	Number of investigations.	Number of publications.
Dietary studies	485	20
Digestion experiments	675	18
Experiments on the effect of different circumstances on the income and outgo of nitrogen	500	(a)
Respiration calorimeter experiments	88	6
Experiments on effects of cooking on meats	157	3
Experiments on losses in cooking vegetables	12	1
Investigations on changes and losses in bread making	3	2
Special investigations	5	2
Compilation of data		4
Preparation of popular summaries		30

[a] These investigations are included in the publications reporting digestion experiments.

In addition to the popular summaries and the technical bulletins included in the above table, a large number of briefer summaries have been prepared which have appeared in the series of farmers' bulletins entitled "Experiment Station Work," and for the last ten years the subject of food and nutrition has constituted one of the divisions of the Experiment Station Record, and abstracts of the current literature of the subject have appeared regularly.

DISTRIBUTION OF THE WORK.

The cooperative investigations of the Office of Experiment Stations have been carried on in a considerable number of institutions in 21 States and Territories. The following brief summary arranged alphabetically by States shows the localities in which the investigations have been prosecuted and the names of the cooperating institutions:

Alabama.—Tuskegee Normal and Industrial Institute.

California.—University of California and California Agricultural Experiment Station.

Connecticut.—Wesleyan University, Storrs Experiment Station, and Connecticut Bible Normal College.

Georgia.—University of Georgia.

Hawaii.—Hawaii Agricultural Experiment Station.

Illinois.—Hull House, Chicago; Lewis Institute, Chicago; University of Illinois and University of Chicago.

Indiana.—Purdue University.

Maine.—University of Maine and Maine Agricultural Experiment Station.

Maryland.—Baltimore Board of Charities and several public institutions in Baltimore.

Massachusetts.—Massachusetts Institute of Technology, Boston; School of Housekeeping, Boston; Wellesley College, Harvard University, and Bible Normal College, Springfield.

Minnesota.—University of Minnesota and Minnesota Agricultural Experiment Station.

Missouri.—University of Missouri.

New Jersey.—New Jersey Agricultural Experiment Station.

New Mexico.—New Mexico College of Agriculture and Mechanic Arts and New Mexico Agricultural Experiment Station.

New York.—Cornell University, Ithaca; Association for the Improvement of the Condition of the Poor, New York; New York Christian Alliance, New York, and Columbia University, New York.

North Dakota.—North Dakota Agricultural College.

Ohio.—Lake Erie College.

Pennsylvania.—Philanthropic institutions, Philadelphia; Drexel Institute, Philadelphia, and Pennsylvania College for Women, Pittsburg.

Tennessee.—University of Tennessee.

Vermont.—Vermont Agricultural Experiment Station.

Virginia.—Hampton Normal and Agricultural Institute and University of Virginia, Charlottesville.

Mention should also be made here of other investigations, which though not strictly a part of the cooperative inquiry yet are so closely related to it that they may be included in the summary. On behalf of the New York State Commission in Lunacy an extended series of dietary studies was undertaken in New York hospitals for the insane, under Professor Atwater's direction, as were also studies at the Elmira Reformatory, New York. For a number of years a sum of money has been granted by the Carnegie Institution for nutrition investigations at Middletown, Conn., and the work has been so planned that it supplemented the investigations there carried on under the auspices of this Department.

SOME RESULTS OF THE NUTRITION INVESTIGATIONS.

It is difficult to measure the results of scientific investigations in the usual units, particularly when the data sought are in a considerable degree educational. When, as in the case of nutrition investigations, the results have also a very decided practical value and are capable of application on every farm and in every home, such an estimate of values is even more difficult. An idea of the returns given for the money invested may be gathered from the fact that since the institution of the investigations in 1894–95, the total sum appropriated for this work has been $222,500. The total number of dietary studies made has been 485, each study having covered from three to thirty days. The total number of digestion experiments with men has been 675, and in general each experiment has covered three days. Supplementing this phase of the work 300 artificial digestion experiments have also been made. The total number of metabolism experiments has been 500, of which 88 have been experiments with the respiration calorimeter. These latter experiments have covered a total of 270 experimental days. The total number of cooking experiments has been nearly 200.

In addition to the above, a number of miscellaneous experiments have been made for the study of special problems, and the studies of pedagogical problems have likewise been numerous.

As a result of the work 30 farmers' bulletins and 50 technical bulletins have been published, as well as numerous short popular summaries.

In earlier statements [a] which have been published, attention has been called to some of the important results of nutrition investigations and at this time reference will be made to some of the later work.

DISTRIBUTION OF FOOD MATERIALS IN THE DIET.

Food habits vary greatly in different regions of the United States, and articles of diet which are popular in one region are almost unknown in another. There are certain staple foods, however, such as meat and bread, which are obviously common to all regions, and it is generally conceded that such staple foods are the principal sources of nutritive material in the diet. The proportion of nutrients and energy which different classes of food materials supply in the diet of the average American family is a matter of considerable interest, and the table which follows and which is based on the results of 376 dietary studies gives results which may be regarded as fairly conclusive.

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[a] Some Results of Dietary Studies in the United States. Reprinted from U. S Dept. Agr. Yearbook, 1898.

Scope and Results of the Nutrition Investigations of the Office of Experiment Stations. Reprinted from U. S. Dept. Agr., Office of Experiment Stations Ann. Rpt. 1901.

Investigations on the Nutrition of Man in the United States. U. S. Dept. Agr., Doc. No. 713.

Proportion of nutrients furnished by different food materials in average of 376 American dietary studies.

Food materials.	Total food material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOODS.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Beef and veal	7.2	16.7	13.2	....
Lamb and mutton	.9	2.1	2.6	....
Pork, including lard	7.2	9.3	42.1	....
Poultry	.7	1.6	.9	....
Total meats	16.0	29.7	58.8	....
Fish	1.8	3.5	1.0	....
Eggs	2.1	4.1	2.9	....
Butter	1.6	.3	16.6	....
Cheese	.3	1.0	1.1	....
Milk and cream	16.5	8.7	8.0	3.6
Total dairy products	18.4	10.0	25.7	3.6
Unclassified animal foods	.2	.2	.2	.3
Total animal foods	38.5	47.5	88.6	3.9
VEGETABLE FOODS.				
Wheat flour, patent	12.2	19.4	1.5	25.6
Wheat flour, entire	.1	.1	....	.2
Wheat flour, graham	.1	.2	....	.2
Wheat preparations	.3	.5	.1	1.0
Wheat bread, patent	5.8	8.1	1.6	12.4
Wheat bread, entire	....	....	....	.1
Wheat bread, graham	.1	.1	....	.2
Crackers	.3	.5	.5	1.0
Sweet cakes, etc	.6	.8	.9	1.4
Corn meal and flour	8.7	10.1	3.8	13.7
Corn preparations	.2	.2	.1	.4
Oatmeal and preparations	.5	1.0	.5	1.1
Rice	.3	.3	....	.9
Rye	1.3	1.6	.1	3.1
Barley and buckwheat	.1	.1	....	.5
Total cereals	30.6	43.0	9.1	61.8
Sugar, molasses, etc	5.4	....	....	17.5
Starch (prepared)	....	....	....	.1
Dried legumes	1.0	2.9	.2	1.7
Fresh legumes	.6	.4	....	.3
Tubers and yams	12.5	3.8	.3	8.3
Other vegetables	6.2	1.6	.5	1.7
Total vegetables	20.3	8.7	1.0	12.0
Fresh fruits	3.8	.3	.3	2.5
Dried fruits	.6	.2	.1	1.2
Total fruits	4.4	.5	.4	3.7
Nuts	....	....	.1	....
Unclassified vegetable foods	.5	.1	.2	.6
Total vegetable foods	61.2	52.3	10.8	95.7
Miscellaneous food materials	.3	.2	.6	.4
Total food materials	100.0	100.0	100.0	100.0

As will be seen from the above table, meats and poultry furnish not quite twice as much protein as all other animal foods together, and of the meats beef and veal together furnish in round numbers half of the protein supplied by the group of total meats. As sources of fat, meats furnish a little over twice as much as is supplied by all the other animal foods, pork being the most important of the meats in this respect. Dairy products are the most important animal

foods aside from meats, milk and cream together furnishing 10 per cent of the total protein and 26 per cent of the total fat of the diet. The animal foods furnish less than 5 per cent of the total carbohydrates of the diet, this important food constituent being supplied almost exclusively by the cereals and other vegetable foods. It will be seen that the animal and vegetable foods are about equal in rank as sources of protein, some 52 per cent of the total protein being supplied by the vegetable foods, and the cereals furnishing 43 per cent are the most important members of the group. Little fat is furnished by vegetable foods, the group as a whole supplying only 11 per cent of the total amount in the diet.

DIETARY STUDIES.

As a result of the numerous dietary studies and kindred investigations, which form a part of the nutrition investigations, dietary standards have been proposed which experience has shown are satisfactory guides for the purchase of food supplies for families and institutions. These so-called standards have been reported and discussed in earlier publications[a] and need not be referred to further. How far these so-called standards represent the physiological demands of the body is a question which needs further investigation.

In the case of actual energy requirements it is obvious that the amount required can not be less than the total quantity given off by a fasting man performing no external muscular work. This question and similar phases of the subject have been studied with the respiration calorimeter and the results are referred to on page 368. As regards actual protein requirements, it seems very probable that the quantity varies with different physiological conditions and other circumstances and further investigations are needed before final deductions are warranted.

The dietary studies have furnished a number of factors showing the amounts of food required by children of different ages and by women as compared with a man at moderate muscular work. These factors have been referred to in detail elsewhere.[a]

In earlier work no account was taken of the variations in food requirements in old age as compared with middle life. A number of the more recent dietary studies have been made in old-age homes and similar institutions, and as a result of this work the conclusion has been reached that the energy requirements of men and women past middle life are practically the same per kilogram body weight, and that such persons require nine-tenths as much food as an adult man in full vigor who is engaged in moderate muscular work.

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[a] U. S. Dept. Agr., Farmers' Bul. 142.

One of the most obvious applications of the results of the nutrition investigations is found in the commissary department of large public institutions and in general in the feeding of large groups. Available data and experimental methods make it possible to examine the diet under such conditions and pass upon its adequacy and real value, as related to its cost, in much the same way that an expert accountant can pass upon the financial condition of any business enterprise. It is often possible to point out ways of checking waste and diminishing cost, or of improving the character of the food without additional expense.

As an illustration of the importance of nutrition investigations in public institutions it may be said that as a result of studies carried on for several years in large institutions in one of the Eastern States very considerable savings were affected, while the diet as a whole was improved. An examination of the accounts of one of these institutions showed a per capita saving of 13.7 per cent in the second year of the work over the per capita expenditure for the first year, and this reduction is all the more striking in view of the fact that during the year in which it was made the price of a large number of the food materials used had advanced very materially. A similar saving was effected in a number of institutions, and it seems fair to conclude that the results were applicable to all the public institutions in the State. The total cost of the food supplied to all the institutions in the State at the time the studies were made was considerably over $1,000,000, and if a similar saving had been made in all these institutions the total saving would have been more than $150,000 per year.

In general, it may be said that the importance of applying the results of the nutrition investigations in the providing of food for public institutions, in the provisioning of camps and expeditions, in regulating the commissary department of the Army and Navy, and in determining the diet in schools and colleges, as well as in the home, is becoming more generally recognized each year as is shown by the many applications made to the Department for information along these lines and the numerous requests for aid in carrying on experimental dietary studies and other investigations.

DIGESTION EXPERIMENTS.

It has long been a custom with physiologists to calculate the digestibility of food of various kinds with the aid of average factors when it was not possible to determine digestibility by actual experiments. Since it is the food digested and not the food eaten which is of special importance to the body, it is very often desirable in discussing the results of dietary studies to consider digestible nutrients rather than total nutrients, and the data desired may be readily

calculated by the use of factors. The following table shows the factors for calculating the digestibility and fuel value of nutrients in a number of single foods and groups of food materials, which have been deduced from the large number of digestion experiments carried on in connection with the nutrition investigations of the Office. A comparison of calculated results with data obtained from natural digestion experiments has shown that these factors are reasonably accurate, and it seems fair to say that they are more satisfactory than any which have been hitherto proposed.

Factors for calculating digestibility and fuel value of nutrients in food materials.

Classes of food materials.	Protein.				Fat.				Carbohydrates.				Energy-proportion of total actually available.
	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram. Total nutrients.	Fuel value per gram. Digestible nutrients.	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram. Total nutrients.	Fuel value per gram. Digestible nutrients.	Proportion of total in mixed diet.	Digestibility.	Fuel value per gram. Total nutrients.	Fuel value per gram. Digestible nutrients.	
	P. ct.	*P. ct.*	*Cals.*	*Cals.*	*P. ct.*	*P. ct.*	*Cals.*	*Cals.*	*P. ct.*	*P. ct.*	*Cals.*	*Cals.*	*P. ct.*
Meat and fish	33	97	4.27	4.40	63	95	9.03	9.50	4	98	3.82	3.90	87
Eggs	4	97	4.37	4.50									89
Dairy products	10	97	4.27	4.40	26	95	8.79	9.25					93
Annual food (of mixed diet)	47	97	4.27	4.40	89	95	8.93	9.40	4	98	3.82	3.90	89
Cereals	43	85	3.87	4.55	11	90	8.37	9.30	62	98	4.11	4.20	91
Legumes (dried)	3	78	3.47	4.45					2	97	4.07	4.20	83
Sugars	-----	-----	-----	-----					18	98	3.87	3.95	98
Starches	-----	-----	-----	-----					-----	98	4.11	4.20	98
Vegetables	6	83	3.11	3.75					10	95	3.99	4.20	91
Fruit	1	85	3.36	3.95					4	90	3.60	4.00	88
Vegetable food (of mixed diet)	53	85	3.74	4.40	11	90	8.37	9.30	96	97	4.03	4.15	92
Total food (of mixed diet)	103	92	4.05	4.40	100	95	8.93	9.40	100	97	4.03	4.15	91

The table shows that the different food materials and groups of food materials vary greatly in the thoroughness with which they are assimilated. Meats of different sorts, as ordinarily prepared for the table, and indeed animal foods as a whole, are more completely digested than the common vegetable foods. Considering foods as a whole, 96 per cent of the total organic material is digested and 91 per cent of the energy is available. In other words, on an average the body rejects only about 4 per cent of the nutrients and about 9 per cent of the energy supplied by the food.

RESPIRATION CALORIMETER EXPERIMENTS.

In conducting experiments of various kinds it is often very desirable to know every requirement of a subject engaged in muscular work. The exact measurement of energy expenditure is time consuming and requires special apparatus, but with the aid of the factors deduced from the large number of experiments which have been made with

the respiration calorimeter the desired data may be calculated approximately. In the experiments referred to all grades of muscular activity have been tested, from the quiet of a fasting subject in deep sleep to the excessive muscular work of a professional bicycle rider whose powers were taxed to the utmost. When muscular work was performed other than that involved in the ordinary motions essential to eating and drinking and moving about in the respiration chamber, the muscular exercise consisted in operating a bicycle-like apparatus. The ease with which the wheel turned, and hence the severity of the work could be regulated, and the total amount of work performed could be accurately measured.

It will be remembered that in discussions of body energy the amount of work is measured in terms of heat, the calorie being the commonly accepted heat unit. It should also be said that under usual conditions the total heat output during a given period affords an indication of the muscular activity of the body. When the body is quiet the heat output is small and when it is active the heat output is correspondingly larger, and the same is true of the carbon dioxid output. The average results of the experiments showing the output of carbon dioxid and heat for the body under the different conditions indicated are summarized in the table following, and with the aid of such data the total carbon dioxid and heat output, and hence the total energy output of the body, may be calculated.

Average normal output of carbon dioxid and heat from the body.

Conditions of muscular activity.	Average quantities per hour.	
	Carbon dioxid.	Heat.
	Grams.	*Calories.*
Man at rest, sleeping	25	65
Man at rest, awake, sitting up	35	100
Man at light muscular exercise	55	170
Man at moderately active muscular exercise	100	290
Man at severe muscular exercise	150	450
Man at very severe muscular exercise	210	600

It will be seen that the output not only of heat but also of carbon dioxid is very nearly proportional to the amount of muscular work. As an example of the way in which the data included in the table may be used for calculating the carbon dioxid and heat output under varying degrees of muscular activity the following may be cited:

If a man sleeps eight hours per day, we may say that the carbon dioxid output during this period is approximately eight times the hourly amount eliminated during sleep by the average subject, or 8 by 25 = 200. If he is at very severe muscular labor for eight hours, the carbon dioxid output would correspond to eight times the hourly amount for very severe work, that is, 8 by 210 = 1,680. And if the

remaining eight hours of the day were devoted to going to and from work, eating, sitting, etc., corresponding, say, to six hours of rest and two hours at light muscular exercise, the carbon dioxid output will be six times the average amount eliminated per hour at rest, that is, 6 by 35 = 210 grams, and two times the amount given off at light work, 2 by 55 = 110 grams. The total for the twenty-four hours would obviously be the sum of the quantities mentioned above, or 2,200 grams. The heat eliminated in the twenty-four hours by men at very severe work may be likewise calculated by multiplying the time devoted to sleep, work, etc., by the average hourly output. In eight hours at sleep he would eliminate 520 calories (8 by 65 = 520); in eight hours at work, 4,800 calories (8 by 600 = 4,800); in six hours of rest, 600 calories (6 by 100 = 600); and in two hours at light exercise, 340 calories (2 by 170 = 340); making a total for the twenty-four hours of 6,260 calories.

The investigations made in connection with the respiration calorimeter have furnished the most accurate records yet available of the normal diurnal variations in body temperature. A summary of this work and a discussion of the results which apply to problems of ventilation and other topics have been included in a recent publication of the Department.[a]

SPECIAL STUDIES OF CEREALS, LEGUMES, MEAT, FRUIT, AND NUTS.

As regards the results of special investigations, particular interest attaches to the studies of the digestibility and nutritive value of cereal products. The extensive investigations which have been made with different grades of flour have shown that when ground from the same lot of wheat the standard patent flour furnishes slightly less protein and mineral matter than the coarser flours but surpasses them in digestibility, and so may be fairly said to have a somewhat higher nutritive value pound for pound. The coarser flours have a somewhat laxative effect, which is commonly attributed to their bran content, and are useful in the diet in this way and for the variety which they give. In general, it may be said that flours of all sorts are nutritious and wholesome and among the most important constituents of the diet.

The investigations with cereal breakfast foods have shown that this class of goods so much used at the present time may constitute an important source of nutritive material, and that although the individual products differ less among themselves in nutritive material than is commonly supposed, as a whole they are nutritious and directly comparable with flours of various types. The breakfast foods in which the coarser part of the grain has been removed have

[a] U. S. Dept. Agr. Yearbook, 1904, p. 205.

much the same digestibility and total nutritive value pound for pound as the finer flours, while those which retain the outer portions of the grain are more directly comparable with whole wheat and graham flours.

Studies of the nutritive value of dried legumes have formed an important part of the nutrition investigations and have shown that in general these foods are well assimilated and may be made very important and economical sources of protein in the diet. Particular interest attaches to the results obtained with cowpeas, an important crop in the Southern States but little known in other regions. This legume, which possesses a distinctive and palatable flavor and may be cooked in a variety of ways, has been shown to closely resemble the more common beans and peas in digestibility and nutritive material, and is well worthy of general use.

The investigations with fruits and nuts have demonstrated that these materials may be fairly regarded as economical sources of nutrients and energy, even when used in fairly large amounts, and indicate that an appreciation of their real food value will greatly increase the amounts consumed.

The extended investigations which have to do with the losses sustained when meat is cooked in various ways have shown that the loss is smaller in boiling than in roasting or frying. In general, the principal constituent lost in cooking is water, though when meat is boiled the amount of total substance which is removed may be as great as 20 per cent. Generally speaking, the smaller the cut the greater the percentage loss in cooking. The investigations have also shown that it is possible to control temperature and other factors so that uniform results may be obtained in the preparation of meat in the household or where it is cooked in larger quantities.

PEDAGOGICS OF NUTRITION.

An examination in detail of the courses in home economics given at the fifty or more agricultural colleges and other institutions receiving Government aid will show that the instruction in nutrition is very largely based on the results of the food investigations which have been carried on under the auspices of this Department. The same is true of the courses of instruction along this line given in high schools, universities, medical colleges, and other American educational institutions. The number of text-books on food and nutrition has been comparatively limited, and at present a large proportion of teachers giving instruction in these subjects depend on Department publications to supply this need. It is worthy of note that the newer text-books and handbooks of nutrition and physiological chemistry draw very largely upon the data furnished by these nutrition investigations, and that the authors almost uniformly acknowledge their indebtedness to the Department work and their appreciation of it. A similar

use is made in other countries of the results of the nutrition investigations, and as an instance may be cited the translation into French of a considerable proportion of the nutrition publications in connection with the general movement for the dissemination of information regarding food and nutrition in that country.

As a part of the nutrition enterprise special attention is being paid to the collection of data of use to teachers and its arrangement in pedagogical form, the work being carried on along the lines which have proved so successful in formulating courses in other branches of agricultural education.

CONCLUSION.

Attention has been directed in the foregoing pages to the lines which have been especially followed in carrying on the nutrition investigations of the Office of Experiment Stations, and some of the results of this important agricultural enterprise have been pointed out.

As regards their origin, all foods, both animal and vegetable, are agricultural products. In the past the farmer was very commonly the distributor of his products, and the foods passed directly from the farm to the consumer. At the present day this is much less common, and most of the foodstuffs become articles of commerce before they reach the housewife, and in many cases are manufactured products, as they must pass through the mill, the dairy, the packing house, or other manufacturing institution before they are ready for use.

Briefly stated, the chief object of the nutrition investigations is to secure the better utilization of these varied food products, and it seems fair to say that much has already been accomplished along this line. The housewife in the farm home or in the town has at her disposal a large amount of data regarding the composition, digestibility, and nutritive value of foods and their relative economy as sources of nutrients and energy, which will aid her in making a good use of her available food supply, and will help her to prepare for her family a diet which is rational and suited to their physical needs. At the same time, the investigations have demonstrated the importance of having the daily fare palatable, well cooked, and attractive, and have shown how such requirements may be met without undue cost. The manufacturer and the distributer of food products are likewise helped by the dissemination of knowledge concerning food materials and their preparation, for such knowledge means a greater development of the important commercial enterprises in which they are interested. And finally, the farmer, the cattle raiser, the dairyman, the market gardener, and all who are direct producers of food supplies are benefited, as a knowledge of the important facts regarding the comparative value of different foods can not fail to bring about improved standards of living, and hence a greater demand for the foodstuffs which they alone can supply.

RECLAMATION OF TIDE LANDS.

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During the past three or four years there has been a rapid and continuous increase of interest in the reclamation of the tide marsh lands along the Atlantic coast, and enough has been done to encourage the belief that it will be possible under proper methods to reclaim a great portion of this now almost worthless land and make it valuable for agricultural purposes. All the lands along the coast which are covered or practically covered with salt water at high tide are classed as salt marsh. They extend from the eastern point of Maine to the peninsula of Florida, being broken in places and with irregular boundaries, and vary in width from a few hundred feet to several miles.

CHARACTER OF SOIL.

The soil of these marshes is composed of sediment or silt, mingled with the remains of animal and vegetable life. There is a variety of opinions as to the fertility of this soil, but the chemical analyses of numerous samples, together with the crops produced where tracts have been reclaimed, show that they are extremely productive, and with proper treatment, including the leaching out of the excess of salt, can be made a valuable addition to our agricultural possessions. The soil varies in depth from a few inches to 10 or 15 feet, and usually rests on a bed of sand or clay. In some places, however, the vegetable matter so predominates that the soil is so light that when saturated with water it has a tendency to float. Such lands are called "floating marshes." They are difficult to reclaim, and are not so valuable as others for agriculture, but even these when drained become more firm and make good pasture and meadow. The value of these marshes depends largely upon their elevation above sea level. Large tracts below sea level have been reclaimed by means of costly dikes and expensive machinery for pumping the water, as in the Netherlands, but land always submerged is not strictly tide marsh, and will not be considered in this discussion.

The fluctuation of the tide along the coast varies from 2 to 11 feet, the average being about 4 feet. Where the fluctuation is above this average, drainage without resort to pumping is usually feasible. Dikes serve to keep out the sea at high tide and automatic gates permit the escape of the water through the dikes at low tide.

INDUCEMENTS FOR RECLAIMING.

While the country adjacent to these tide lands was sparsely settled and there was plenty of high land for cultivation, there was neither incentive nor necessity for reclaiming them, but during the last decade these conditions have radically changed. The eastern portion of the United States has become densely populated. Numerous towns and cities have grown up along the coast, creating a great demand for the products of the farm and garden. To make room for this rapidly increasing population and provide a suitable place possessing proper sanitary conditions for residences, and to satisfy the demands for fruit, vegetables, and dairy products, it is necessary to reclaim some of these marsh lands.

Within the last ten years the scientists of the country have proved conclusively that certain species of the mosquito are the most common, if not the only, means of disseminating the germs of malaria and introducing them into the human system. In places where the mosquito has been exterminated malarial diseases have greatly decreased or entirely disappeared. It is a well-established fact that the tide marshes are a serious menace to the health of the people in their vicinity and a great hindrance to the settlement and development of the country in that locality. They breed mosquitoes by the million, which destroy the comfort and enjoyment of the people and greatly annoy the domestic animals.

These waste places, rich in fertility and having an ample supply of moisture for plant growth, only need draining to enable heat and air to penetrate the ground to make them ideal locations for truck gardening on a large scale. Many of these are so situated as to offer economy in transportation which furnishes another important reason for their early reclamation. Either by rail or boat products can be landed cheaply and quickly in the market places of large cities or thriving towns at very little cost. This adds greatly to the commercial value of the land and allows for a much more liberal expenditure for its reclamation than could be borne if there had to be added to the cost of production the cost of a long-distance haul to market.

The desire to reclaim these marshes is evidenced by the many attempts that have been made to do so. That some skill and knowledge in this work are required is also shown by the numerous failures. (Pl. XII.) Works to keep out the sea on one side and prevent rains and storm water on the other from flooding or injuring crops, must be wisely planned and carefully executed. Nothing is so insidious in its attacks as water; and the dikes and drains which form a part of reclamation work on tide marshes have to contend with burrowing animals, with a foundation at first extremely unstable, and must

FIG. 1.—GREAT ST. GEORGE'S MEADOW, NEAR DELAWARE CITY, DEL., SHOWING EARTH EMBANKMENT AND RECLAIMED MARSH.

FIG. 2.—PORTION OF THE CLARK MEADOW, NEAR DELAWARE CITY, DEL., SHOWING RUINED EMBANKMENT IN THE DISTANCE.

anticipate the changes which will be brought about by the drying of the land on one side and withstanding the attacks of the sea on the other. If the plans are inadequate or the work poorly done, failure will surely follow.

These difficulties are understood now better than formerly and the owners of these lands or the communities interested in their reclamation are seeking to avail themselves of all the experience and information both in engineering and agriculture which can be gathered, and they are making many inquiries of the Department of Agriculture as to how particular projects should be carried out, how dikes and ditches should be planned and built, and the land be made ready for the planting of crops. Some of these inquiries are for information and advice about the organization of communities for the carrying out of large projects; others have to do with methods for removing the water and the subsequent treatment of small areas. As these lands, taken together, have an aggregate productive area equal to that of agricultural States like Illinois or Missouri, it follows that their successful reclamation and cultivation means an important addition to the national wealth. Many of the attempts to carry out these works have been delayed or have been prevented for the time by a lack of information and lack of confidence on the part of the landowners directly interested. These landowners are unwilling to sanction the improvement or contribute to its expense until they can be assured through some authoritative or disinterested source that the reclamation of tide marshes is feasible; that the land when drained will be productive; and that this drainage will not interfere with other industries such as the fisheries along the seacoast bordering the marsh lands. They wish to have some knowledge regarding the kind of dikes needed for protection from the sea and the kind of drains and pumps needed to put the land in proper condition for cultivation after the inflowing tides have been cut off. In order to answer these questions definitely and properly the Office of Experiment Stations commenced during the last year an extensive investigation to determine the areas of tide marsh land capable of being drained, the methods to be followed to insure success, and the relative measures of the cost and the benefits to come from this work. This paper is in the nature of a preliminary report on this investigation. Later on it is intended to prepare for publication a report giving more definitely the area susceptible of such reclamation, the measure of the benefits to agriculture which will come from their improvement, and more definite and detailed instruction regarding the methods which should be followed in carrying out this work.

SOME OF THE RESULTS OF DRAINAGE.

About the only agricultural product grown on these lands in their native condition is marsh hay. This hay sells at present in the vicinity of Boston at $8 a ton. On areas which have been drained the hay sells for $25 a ton, and the yield per acre is larger than on the undrained tracts. The simplest form of improvement possible, therefore, increases the productive value of these lands threefold, but the greater part of the lands which have been reclaimed are too valuable for the growing of hay, and have been brought immediately into intensive cultivation. (Pl. XIII.) Cranberries are probably the most important crop at present grown on tide marshes. The area of cranberry bogs is being constantly extended and the trade in this fruit has assumed large proportions. Cranberry growing during the past two or three years has been quite profitable, and this has resulted in a marked activity in the extension of the area devoted to the crop and to the value of the lands reclaimed. Good bogs along the North Atlantic coast now sell for $1,000 an acre and pay a large return on this investment. The need of these marshes for truck farming is more apparent now than formerly because of the great increase in the number and population of some seaside resorts. Along Cape Cod and much of the Massachusetts coast the uplands have not the fertility needed for successful gardening. Much better results can be had from these marshes when drained than from the higher lands. In many places the growing of fresh vegetables in the immediate vicinity of town, requires the reclamation of marshes, and they are proving well adapted to this use. Asparagus grows with unusual vigor in such soil, and in places near Boston excellent crops are being produced where the marshes are occasionally flooded with sea water. Celery does excellently in some localities, but has failed, for reasons not well understood, in others. Cauliflower, cabbage, onions, muskmelons and watermelons, cucumbers, lettuce, sweet corn, field corn, potatoes, oats, redtop, timothy, and alsike clover are all crops being successfully grown on reclaimed marsh lands along the North Atlantic coast; onions, celery, asparagus, cucumbers, and melons being the most profitable crops.

For many years the tide marshes of the South Atlantic coast were largely devoted to rice growing, and this is still the most important use of these areas, but changes in the flow of the rivers, which have taken place as the result of the removal of the forests and from other causes not so well understood, are bringing about a change in these lands, under which they are being more and more converted into truck farms. Asparagus, peas, potatoes, lettuce, beans, and cabbage are being raised in large quantities and shipped to the northern

FIG. 1.—CROP OF ONIONS ON RECLAIMED SALT MARSH, REVERE, MASS.

FIG. 2.—CROP OF HAY ON DIKED MEADOW, MARSHFIELD, MASS.

markets for sale early in the season. The products are of good quality, the business is proving profitable, and the area is being continually extended. There are, however, as yet many unsettled questions connected with this kind of agriculture. The best methods of growing crops, and the varieties of crops best suited to these conditions are not as yet determined, but this is being systematically investigated by the Bureau of Plant Industry of this Department. The requirements of drainage, the depth to which the water level must be lowered and kept, and the kind of devices or machines needed for this work are being studied by the Office of Experiment Stations as a part of its drainage investigation.

DRAINAGE IN EUROPEAN COUNTRIES.

The most notable example of the reclamation of salt marshes is furnished by the Netherlands. Here the work has been carried on for centuries, during which a large part of Holland has been wrested from the sea. Lands no more fertile than the marshes of this country now support a population of 450 to the square mile, while the density of population in New Jersey is but 250 and that of New York 153. These figures show the possibilities of salt marshes in the climate of the North Atlantic States. Equally encouraging evidence of the value of the marsh lands of the South Atlantic seaboard is furnished by the results of draining the low lands of Italy along the Adriatic Sea. This work was begun in a systematic way in 1882. Before that time the cost of constructing efficient drainage works was beyond the unaided financial resources of individuals or communities. Agricultural progress was practically at a standstill; the health of the population was menaced by malarial conditions and depopulation of some districts was threatened. Foreseeing this danger the Italian Government, after a thorough, detailed study, passed a comprehensive drainage law providing for the organization of districts and for financial aid from the General Government and from the provinces. As a result of this work many thousand acres of land have been reclaimed and is now growing high-priced crops. Land values have been largely increased, and some of the drained districts now have a population of between 400 and 500 to the square mile.

INFLUENCE OF DRAINING TIDE MARSHES ON PUBLIC HEALTH.

Along some parts of the coast of Long Island and New Jersey efforts have been made to drain the marsh lands as a means of ridding neighborhoods of mosquitoes, and have been partially successful; but without a general effort and the drainage of all the marshes in a certain locality the best results can not be secured. A most successful example of the effect of drainage on health conditions is to be seen

in the drainage of the neck at Charleston, S. C. The city of Charleston is located on a tongue of land between the Ashley and Cooper rivers. This land was formerly infested with mosquitoes and was extremely malarious. During the last four years the land has been thoroughly drained. The report of the sanitary and drainage commission of Charleston County, S. C., for 1905, speaking of the results, says:

When we took charge of this territory, ponds and morasses were everywhere. The Anapholes mosquito, the disseminator of malarial poison, was present by the millions. The public road was almost impassable in places, and the public ditches choked up and more or less filled with a stagnant water, and the whole country had the appearance of the utmost neglect, and there were but very few business enterprises with the exception of the fertilizer factories. To-day there are no ponds, no morasses, the Anapholes has been banished, and an avenue 40 feet wide, with ditches on each side, has been built to Tenmile Hill. A new town has been laid out and 100 homes are being erected in this town. New dwellings and new stores are to be seen on all sides.

William Reybold, writing from Newcastle County, Del., says:

If, after reclaimed, marshes are kept well drained, there is less of malarial diseases than when not reclaimed, and the pest of mosquitoes is almost driven away.

A writer from Fairfax County, Va., says:

The marshes are very little utilized, but some have been diked successfully and produce good crops of hay. This matter is of such importance, and the health of the tide-water region, in conjunction with its agricultural advantages, would justify the Government in inaugurating some system of improvement.

John L. Grubbs, of Henrico County, Va., says:

There is a decided improvement in the health of the neighborhood where marshes are diked and drained.

BEST METHODS OF RECLAMATION.

There are three things in the reclamation of salt marsh that require special attention and treatment. These are:

(1) The method of protecting the land from overflow by tide waters.

(2) The plan of internal drainage.

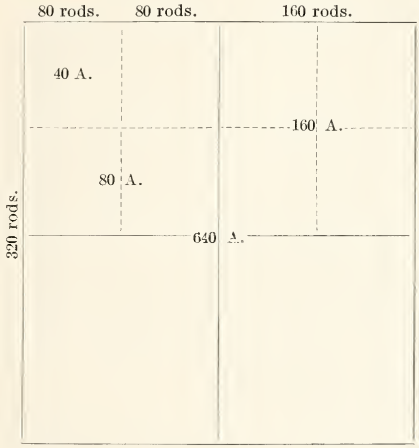
(3) The treatment of the soil to rid it of the excess of salt.

The usual, and probably the best means, of protecting a marsh from the overflow of the tide is an earthen embankment constructed of the material found along the line of the work. The location, size, and character of this embankment are of the utmost importance, as upon its efficiency and stability depend the success of the reclamation. Practically all the failures in reclaiming marshes in both this country and Europe have been due to the lack of proper precautions in the construction of embankments.

LOCATION OF DIKES.

In locating a dike there are many things to be considered:

First. The direction must be such that with the shortest line of dike the greatest possible area may be inclosed. An examination of this principle shows that the larger the area to be inclosed the less it will cost per acre to do the work. The following diagram illustrates this fact:



In case of a level tract to be inclosed on all sides:

40 acres would require 320 rods of embankment, or 8 rods per acre of area.
80 acres would require 480 rods of embankment, or 6 rods per acre of area.
160 acres would require 640 rods of embankment, or 4 rods per acre of area.
640 acres would require 1,280 rods of embankment, or 2 rods per acre of area.

Marsh lands are frequently so situated that they do not require embankments on all sides; yet this general rule holds good—the larger the area the less the cost per acre to inclose it. This shows the importance of cooperation in this work. Where the marsh is held in small tracts, as is the case in many of the New England and Middle Atlantic States, it can be embanked at a much less cost per acre if the owners organize into districts as they do in some parts of Nova Scotia and New Brunswick. There they have dike laws for reclaiming and protecting tide marshes. The principle of these laws is very much like those of the drainage laws in some of our States, and under their operation much work has been done that could not have been accomplished by individual effort. Under the dike laws whole townships of the best agricultural lands have been created from worthless bogs and morasses.

Second. The dikes should run parallel with the coast or stream, or else at right angles to it, and should have a wide berm or foreshore between the toe of the slope and the water's edge. The action of the waves is less destructive when they strike the bank at right angles than when they strike it obliquely, and they also do less damage where there is a wide berm in front of the dike. Experience shows that dikes which lie directly on the brink of the shore are much more liable to injury than those which lie farther in and have

some land before them. In no case should the width of the berm be less than that of the base of the dike, and when the embankment is exposed to the action of the wind or waves it should be 100 feet or more in width. The distance from the shore must be determined in a great measure by the quality of the ground. It should be located far enough away from the stream or shore to be secure against undermining by caving.

HEIGHT OF EMBANKMENT.

After locating the dike the height is the next important element to be considered. No one can tell with certainty to what point a storm tide at any point will rise, but when observations extend over a long term of years the greatest height reached may be safely taken as the maximum that is likely to occur in the future. The height of the embankment should be at least 18 inches above this mark. This may seem excessive, but nothing less is absolutely safe. When the waves reach near to the top of the embankment and a strong wind prevails, much damage is likely to occur, and in case they overtop the embankment the entire work may be greatly impaired or even destroyed.

CROSS SECTION OF EMBANKMENT.

The form of dike best suited to turn water and its proper dimensions are matters of the greatest importance. In nearly every case of failure the cause has been found to be that the embankment was not high enough and was overtopped by the waves, or the cross section was too light to withstand the pressure. For the cross section of the dike it is not enough to obtain ample strength to resist the force of the water on the dike but this strength must be obtained at the lowest possible cost.

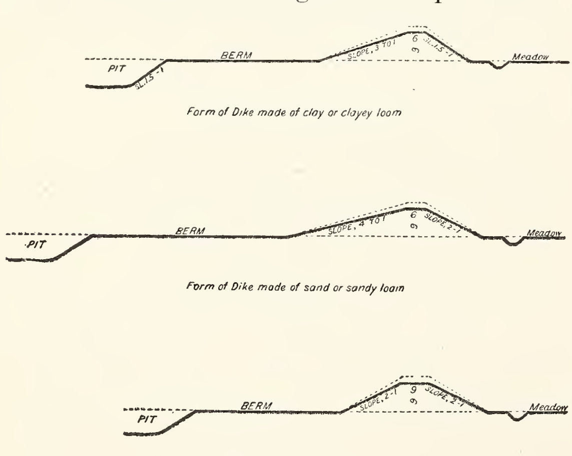


FIG. 2.—Forms of dike made from different materials.

The form and area of the cross section of the embankment depend largely upon the character of the material out of which the embankment is made and the length of time the water will remain against

it. Where the material contains a large percentage of clay, a smaller cross section may be safely used than where the material contains a large amount of sand and vegetable matter (fig. 2). Experience has shown that the top width should be two times the square root of the height, with bank slopes on the water side of not less than 3 horizontal to 1 perpendicular and on the land side as steep as the material will stand without sloughing, which is usually 1 or 1½ horizontal to 1 perpendicular. This has proved to be the most economical cross section that can be constructed to safely withstand the water that may come against it. When the material is more or less sand or sandy loam, to insure safety it is necessary to increase the slope on the coast side from 3 to 1 to 4 to 1, and where exposed to the influence of the wind it ought to be 5 horizontal to 1 perpendicular in order to break the force of the waves and prevent washing. Where the material is of a peaty nature with a mass of fibrous roots, a better practice seems to be to increase the top width to that of the height and make the slopes on either side 2 to 1. This form seems to withstand the seepage better than a narrow top and a slight slope when the material is of a fibrous nature.

The Mississippi River from Cairo to New Orleans is restrained by levees built of sandy loam. Large areas of Nova Scotia and New Brunswick have been protected for centuries by dikes built of marshy soil, and the dikes that protect Holland from the sea are in most part made of sand. There is no occasion for failure on the Atlantic coast if the embankments are properly located and carefully constructed, but great care must be given to the details of the work to insure success.

SPECIFICATIONS FOR BUILDING EMBANKMENTS.

The ground should be cleared of all coarse vegetable matter and a strip in the center one-half as wide as the base should be broken up with a plow or spade (fig. 3). Where the ground is very wet or covered with water, a successful method is to excavate a ditch 5 feet wide and about 18 inches deep along each side of the base of the embankment 6 feet inside the toe and parallel therewith, placing the earth excavated on the outside of the ditches so as to form the toes of the slopes, the trenches being refilled with new material as the bank is made. This preparation will disclose any underground timbers and channels and prepare for a proper union between the base and the new material. All stumps and logs should be removed from the base and should there be any old trenches they should be

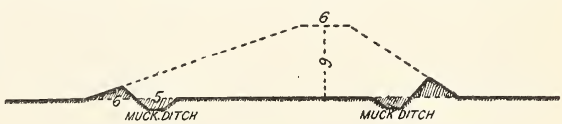


Fig. 3.—Method of preparing base in marsh lands.

cleaned of all silt and vegetable matter and filled with fresh earth. Neglect of any of these small precautions may lead to a break in the levee causing great damage. The bulk of the material for building the embankment should be taken from outside, leaving a berm as wide as the base of the levee, from which no material is taken, and the borrow pit should be broad and shallow next to the berm and increasing in depth as it recedes from the embankment.

It is permissible, and often advisable, to take sufficient earth from the land side of the levee to form a drainage ditch. This cuts off the seepage and protects the land inclosed, and also strengthens the levee by keeping it well drained. Where the line of levee crosses low places it is a good plan to build up the berm to the general level. This strengthens the embankment by reducing its height on the water side.

In constructing a levee proper allowance should be made for shrinkage. Material such as is usually found shrinks when dry from one-fifth to one-eighth owing to the method in which it is placed in the embankment. To be on the safe side, it is well, therefore, to increase the height of the levee one-fifth, leaving the width of the base and width of top the same as specified for the finished work. This will allow the necessary settling to take place and still leave the levee as high as the established grade.

METHOD OF DOING THE WORK.

In building embankments the earth is usually handled in one of three ways: (1) By spade and wheelbarrow; (2) team and scraper, or team and dump cart; and (3) some form of dredge.

Where the embankment is small the earth can be dug with a spade and thrown into place at a cost of 8 to 12 cents per cubic yard, according to the price of labor and the stickiness of the soil. Where the embankment is larger and it is necessary to leave a wide berm the earth can be dug and transported in wheelbarrows at a cost ranging from 12 to 20 cents, according to the price of labor and the distance the material has to be conveyed. This method is expensive and should be used only in places where the quantity to be handled is too small to justify the outlay for some modern plant.

Where the ground is firm enough to permit the use of teams and wheel scrapers the earth can be handled quite rapidly at about one-half the cost of wheelbarrow work, but where the ground is soft and boggy, as is the case in most places along the Atlantic coast, it is impracticable to use teams and scrapers. Where the yardage is large enough to justify the outlay, the cheapest and most satisfactory way of building an embankment is by means of a dredge of some type.

The improvement in excavating machinery during the past ten years has developed some very good dredges for this class of work.

By selecting a machine adapted to the conditions, excellent work can be done at a very low price.

FLOATING DREDGE.

Where the ground is very soft a floating dipper or clam-shell dredge boat, as shown in the accompanying drawings, can be used to good advantage. The machinery (engine and boiler) is mounted on a barge that floats in the excavation and the material dug with the dipper is placed in the embankment by means of a swinging boom. A clam-

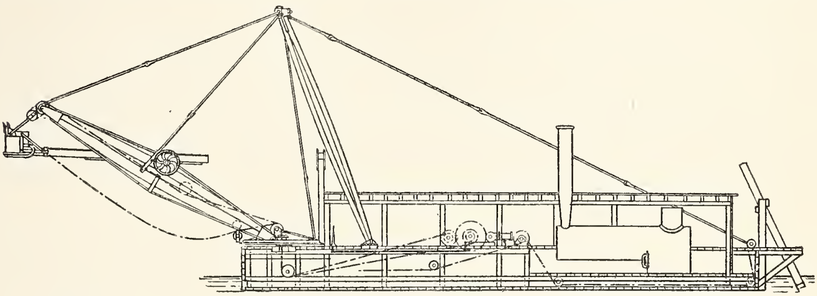


FIG. 4.—Outline of dipper dredge suitable for ditching and for building small dikes.

shell is better than a dipper dredge (fig. 4) for this kind of work, as it is possible to use a much longer boom, thereby leaving a wide berm between the pit and the toe of the embankment. Machines of this type have been successfully operated with a boom 120 feet long carrying a bucket holding 2 cubic yards, but the dredge best suited

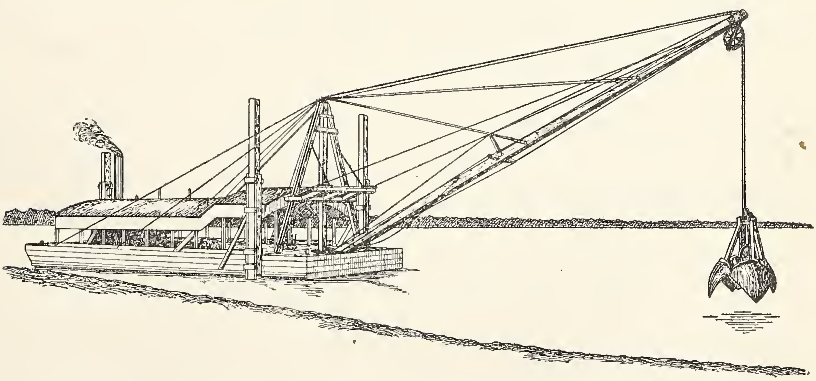


FIG. 5.—Long boom dredge with orange-peel bucket, suitable for building large embankments.

to the conditions along the coast is one having a boom 80 to 90 feet long and a bucket holding 1 to 1½ cubic yards (fig. 5). The advantage of this method of construction is that the levee is built in layers of wet material and is very compact and firm and permits little or no seepage during times of high water.

TRACTION DREDGE.

Where the ground is firm enough for a man to walk, a more satisfactory way is to use a traction dredge with a swinging boom and a clam-shell bucket (fig. 6). In this case the machinery is mounted on a platform that moves on rollers or is self-propelling on a temporary track. It digs in front and backs away from the work (fig. 6). With a machine of this kind very large embankments may be built, leaving a wide berm and a shallow pit. Traction dredges of this type with a boom 100 feet long and carrying a $2\frac{1}{2}$-yard bucket, are successfully used for levee building along the Mississippi River. Where there are no stumps or logs an embankment can be built with any type of dredge as above stated, at a cost ranging from $3\frac{1}{2}$ to 6 cents per cubic yard. Although this method of constructing embankments is very cheap it is only practicable where there is a large quantity of material to be handled, as it is very expensive installing a dredge suitable to do the

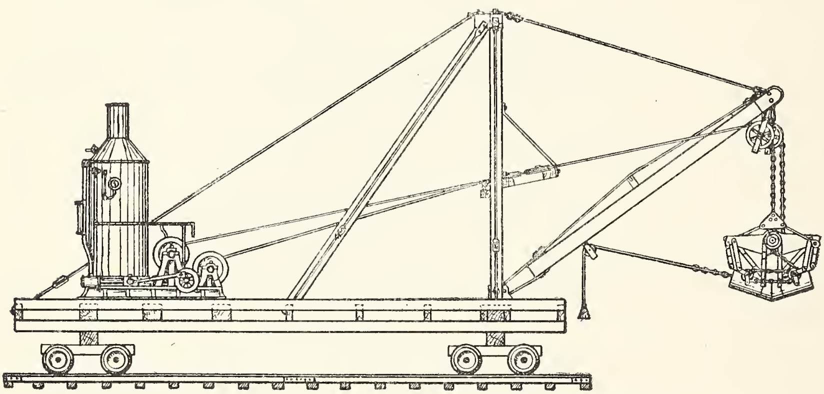


FIG. 6.—Type of traction dredge suitable for building dikes.

work. This is one great reason why cooperation is necessary to successfully reclaim the greater part of the salt marsh under consideration.

In building levees with a dredge the different layers of material are more thoroughly mixed than when put up with hand labor and make a much more compact and impervious embankment.

ELEVATOR AND SUCTION DREDGES.

Elevator and suction dredges discharge so much water with the material they excavate that they are not well adapted to building levees. They have, however, been used quite successfully in some places by building parallel walls of turf and sod to hold the material until the water drains out. The great difficulty in building a levee with a dredge is to get one with a boom or carrier long enough to place the material in the embankment without digging a deep pit too near

the toe of the levee. Where the ground is firm enough to use a traction machine this difficulty is overcome as the machine can be run on the berm between the toe of the levee and the pit, as shown in the annexed cut (fig. 7). When a sufficient amount of material has been placed in the embankment to secure the proper width and cross section it should be dressed to a smooth surface and planted in some species of grass that will form a tough sod. South of Virginia the Bermuda grass is the best for this purpose, while along the north coast red top or herd's grass seems to be best suited.

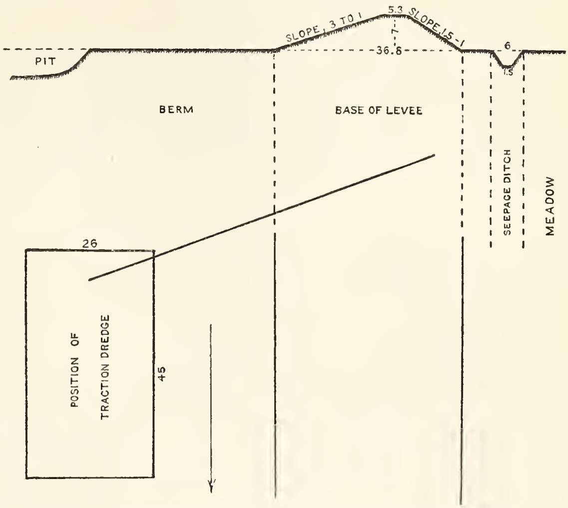


Fig. 7.—Relative position of borrow pit, dredge, and levee.

WAVE PROTECTION.

Where a levee is exposed to high winds it should be protected from wave wash when first put up until the sod is formed and the material thoroughly settled. This can be done as follows: Plant a row of 6 by 6 posts along the berm about 3 feet from the toe of the levee and bolt a stringpiece 4 by 8 to the front of these posts at about the elevation of high tide. If the posts are more than 6 feet out of ground, another piece should be bolted on about 1 foot above the ground. Drive a double row of sheet piling 2 by 6 or 2 by 8 on the front side of this stringer, inclining about 1 foot horizontal to 6 feet vertical toward the levee. The pieces should be driven so as to break joints with each other and penetrate the ground 3 feet. The planking should be further secured by placing a waling piece 2 by 6 or 2 by 8 on the front side opposite the stringer and securing it by screw bolts passing through the waling strip, sheet piling, and stringpiece at intervals of 6 feet. At each post the barrier should be braced by a strut of 3 by 8 secured at one end to the top of the posts by means of screw bolts or spikes and extending back almost horizontal to the surface of the levee, where it should be securely spiked to a stake 2 by 6 driven firmly into the ground. A barrier thus constructed breaks the action of the waves and at the same

time does not injure the levee, but leaves it so that it can be mowed and kept clear of noxious weeds. Protections placed directly against the slope form a refuge for muskrats and other pests that destroy the levee. If made of creosoted lumber, it will not be attacked by toredo and will last a great many years. The surface of the embankment should be kept in grass and be carefully mowed at least twice each year. This will destroy the refuge for burrowing animals, improve the sod, and become a source of revenue.

TIDE GATES.

When embanking a piece of marsh, provision must be made for discharging the water that accumulates within the embankment. Where the land is sufficiently above low tide, this can be most easily accomplished by means of a sluice or tide gate. This provision for the escape of the water is an essential feature of the reclamation, and, like the embankment, must be properly designed and well built. The ultimate success to be achieved in reclaiming salt marsh and rendering it fit for meadow or cultivation depends almost wholly on the character and efficiency of the tide gates devised and erected to keep out the salt water. They must be of a permanent character, substantially built, and so constructed as to open and close promptly with a minimum amount of pressure. Care should be taken in placing the abutments that carry the gate to see that they have a firm foundation and that the flow line of the chamber is slightly above mean low tide. What is known as the tankard gate, suspended by a double hinge so as to readily close against the face on all sides, is recommended. The seat is lined with rubber so as to form a tight joint with the abutment, and if carefully constructed will not allow any water to pass when closed. As the gate is necessarily heavy, an adjustable counterweight is attached so that it may be nicely balanced in order to open with a small head against the upper side. The position in which it is hung will cause it to close by gravity as soon as the pressure on the inside is exhausted or overcome by an equal pressure on the other side. In designing the gates to accommodate a large volume of water, it is deemed better practice to make a series of smaller ones having the required opening, as they can be much lighter and are less liable to warp and spring, causing leaks when closed. The relative merits of steel and wooden gates have been considered, but owing to the difficulty in building and holding structural work in a true plane and the deleterious effects of salt water on steel and iron, it is thought that gates of creosoted timber are better suited for the purpose. The treatment of any porous wood, preferably white or yellow pine, free from heart, with 14 pounds of creosote oil per cubic foot, will insure the material against decay, prevent it from swelling and shrinking, and protect it against the

ravages of the toredo. Such gates are no more expensive than steel and are far more desirable. The gates here recommended are so planned that they can be readily detached from the framework without injury to it, if at any time repairs should be necessary.

Plans and complete drawings for a cheap wooden abutment, with one or more gates, as required, and also plans and drawings for a concrete abutment with creosoted wooden gates are given on page 396. This is the most desirable gate that can be constructed, and where sand or shells can be readily procured its cost will be but little more than a wooden abutment serving the same purpose.

The following general directions for constructing either of these gates will serve as a guide for any locality:

EXCAVATION.

The foundation for the abutment should be prepared by excavating the muck and soft material to a firm clay or sand bottom. In order to do this successfully it will be necessary in nearly all cases to drive some form of tongue-and-groove sheet piling, so as to form a tight cofferdam around the proposed pit. A pumping plant of sufficient capacity to keep the pit dry at all times must be provided. The abutment may be of timber, as shown on the first set of plans, or it may be of stone, brick, or concrete, as shown on the second set. In case timber is used, the foundation should be brought up to the proper grade by filling in with good clay or a grouting of broken stone and cement mortar. Great precaution must be taken to make the foundation such that water can not find its way under the timbers, in which case the earth would be washed out and the value of the structure destroyed. In case a firm foundation can not be secured otherwise, round piling, on which to rest the abutment, should be driven in the pit. In the wooden structure the bottom sills can be secured to the piling by means of drift bolts. This will support the structure so as to prevent settling and the water can be shut off by the sheet piling above and below the abutment. Where broken stone or suitable sand can be readily procured, concrete will be found the most desirable material, and we recommend its use. The desired shape for the masonry may be secured by making forms of lumber which can be removed after the mortar has set. The proper proportion of cement and sand to form concrete depends in a measure on the strength of the cement and the quality of the sand used. With any good natural cement and clean, sharp sand a proportion of 1 to 5 or even 1 to 7 would make very substantial work. Methods of mixing and tempering mortar for concrete are so well known that it is hardly necessary to explain them here. The things to be insisted upon in any concrete work are fresh cement, clean, sharp sand, plenty of water, thorough mixing, and immediate use. If these are

observed with due care, good results may be expected. It is quite important to have the face of the abutment both true and smooth in order that the gates may set properly. This can be secured by having the forms in perfect alignment and plastering the face with a fine mortar. The abutment should be level on top when completed, so it may be floored over and used as a bridge for crossing the channel.

HEAD BEAM.

In case of the wooden abutment, the head beam to which the gates are hung is formed by bolting a piece of timber to the cap of the bent, but on the stone or concrete abutment a head beam of 10-inch steel channel weighing 20 pounds per linear foot, from which the gates are hung, should be secured to the face of the abutment, as shown on the drawing. Cast-iron fillers of a suitable pattern may be used at the points of attachment to hold the channel out from the face of the wall the thickness of the gates.

SWINGING GATES.

The essential features of a good tide gate are durability, tight closing, and easy movement. They are made, as shown on the drawing, of two thicknesses of material, the pieces of each layer being at right angles to those of the other. Between the two is placed a sheet of 8-ounce cotton duck, painted on each side with a heavy coat of white lead and oil. The boards in each layer should be drawn up tight with a clamp and securely bolted at each intersection with two machine bolts with wrought washer under both head and nut. To resist the action of the salt water, the bolts and washers should be galvanized. If the workmanship is not of a high class so as to form tight joints, the vertical seams, being the outside of the gate, may be calked with three threads of cotton to prevent leaking. In case creosoted lumber can not be obtained, other lumber may be used, but it should be thoroughly soaked by immersing it in water several days before using. A suitable seat is formed by fitting to the inner side near the edge a piece of 6-ply rubber belting $2\frac{1}{2}$ inches wide. This can be secured to the wood with brass screws $1\frac{1}{4}$ inches long, with heads sunk well below the surface of the rubber. The gates should be hung to the head piece by a double joint or link hinge, as shown on the drawing. Such a hinge allows the gate to adjust itself to the face of the abutment in closing, so as to form a tight joint on all sides, permitting the water to rise above the top of the gate without leaking. A suitable hinge probably can not be purchased in stock, but can be made in any machine shop from the detail drawing furnished herewith. The holes should be true and accurately bored and the bolts turned and neatly fitted, so as to insure free movement. To withstand the action of the salt water, it is desirable to make the hinges of hard brass, or if iron is used it should be kept well painted and the bolts

should be made of hard brass. For the purpose of balancing the gate so it will open and close with a minimum pressure, a projecting arm with an adjustable weight is attached to the inside, as shown on the drawing. When the gate is hung, this weight can be shifted in or out until the position is found where the gate opens with least pressure and then fixed by means of the set screw in this position. A gate constructed as above specified possesses all the essential requisites of a good tight gate. The creosoted material gives it the qualities of durability; the link hinge and rubber cushion allow it to firmly seat itself on all sides and form a tight joint; while a counterweight renders it sensitive to the least pressure. A cheap structure might be erected, but there would be constant danger of its giving way at a critical time, and it would have to be replaced at frequent intervals, so that a permanent structure, even at an increased cost, is more economical.

A bill of material required to construct either the wooden or stone abutment with the necessary gates is given on page 397.

PUMPING PLANT.

Where the fluctuation between high and low tide is not sufficient to afford natural drainage, some kind of pumping plant must be provided to discharge the water. The pump should be placed within the inclosure at the lowest point adjacent to the embankment and should be used to lift only such water as will not flow out during low tide. This water can be discharged through a sluice and need not be lifted over the embankment. A centrifugal pump operated by a steam or gasoline engine is probably the best for this class of work. The size of pump and engine depends upon the area to be drained. From experience in numerous places it seems that where such land is in cultivation the pump should be able to discharge 1,000 gallons per acre per hour to properly protect the crops in times of heavy rains. But where the land is used for pasture or meadow the removal of one-half of this amount is sufficient. The pump and engine should be placed on a solid foundation and carefully housed against damage from the weather. The additional expense incurred in providing substantial foundations for the pump and engine and making an ample sump for the suction pipe will be more than repaid in economy of operation and efficiency of plant. Many crops have been destroyed and much damage occasioned because of the inadequacy of the pumping plant or its failure, owing to faulty construction, at a critical time.

The cost of installing and operating a pumping plant depends largely upon the extent of the tract to be drained. As a rule, the larger the volume of water to be handled the less the cost per acre or per gallon for doing it. Even where the water is ordinarily discharged through a tide gate, it is wise to have an emergency pump to take care of the seepage and rainfall, during periods of high tide when the gate does not open.

INTERNAL DRAINAGE.

After the embankment is completed a system of internal drainage must be constructed to collect the water and lead it to the tide gate or pumping plant. On most tracts there are old channels that can be used to advantage in planning a system of internal drainage that will lessen the cost of excavation. Since the natural drainage is intermittent, effective only at low tide, it must be supplemented by a large storage capacity. Hence the ditches should be made wider than would otherwise be necessary. The removal of one-half inch of rainfall in twenty-four hours from a comparatively level tract of land, when the rainfall does not exceed 60 inches per annum, has proved to be adequate for the successful culture of field crops. If the tide gates are made of ample capacity to discharge all the water from the storage basin at each low tide (twice in twenty-four hours), ditches having a capacity for storing 0.25 inch of rainfall from the entire watershed without raising the water in the ditches more than 1 foot will be sufficient to properly drain the land for either meadow or cultivation. Since most of the salt marshes are practically level, the ditches will have but little grade and will depend upon the hydraulic head to induce a current. As the water nearest the gate will be discharged in the shortest time, it is expedient that the greater part of the storage capacity be as near the outlet as practicable. When the gate opens, this portion will be discharged at once, and should it close before the ditches are entirely empty the water in the more remote laterals will flow into the basin just formed, thus holding the water down to the lowest level to be obtained without pumping.

In planning a system of ditches it should be the aim to locate them in such a way as to leave the land in the best possible shape for cultivation. Where there is high land that drains into the marsh, an intercepting ditch should be cut along the foot of the slope to lead the water into the storage basin without overflowing the low land. The depth of the ditches required and their distance apart depend largely upon the character of the soil. The main ditch should be as deep as the sill of the tide gate, while the laterals should range from $2\frac{1}{2}$ feet deep at the upper end to 3 or $3\frac{1}{2}$ feet at the lower end, according to the depth of the outlet channel. In most places ditches in marsh soil will stand with almost perpendicular banks, owing to the fibrous roots in the material, so to increase the storage capacity they should have wide bottoms, with bank slopes one-half horizontal to 1 perpendicular, unless places should be found where the material requires a greater slope. It is not practicable to give specific directions for laying out a system of internal drainage, as each marsh must be viewed and treated according to its shape and peculiar location.

METHOD OF DOING THE WORK.

Where the work is of sufficient magnitude and the ditches are large enough, the use of a dredge of some type is the most economical way of excavating them; but where the ditches are small, hand labor will be found the most feasible. There are on the market some machines for cutting small ditches, but they can not be successfully operated on a soft marsh.

SUBDRAINAGE.

If it were practicable, tile drainage would be by far the best method to use in the reclamation of salt marsh; but the soil conditions are generally such that tile can not be used. The depth of the outlet in most places is not sufficient to permit them to be laid on the solid ground, and if laid in the muck above the sand and clay they would settle out of alignment and fill with silt. It is highly probable that after a term of years the marsh will settle and become sufficiently firm to permit the use of tile in some of the ditches.

TREATMENT OF SOIL.

After the dikes or embankments have been completed so as to exclude the tide and the drains constructed so as to collect the rainfall and seepage, and some reliable method provided for discharging the water from within the inclosure, the soil must be prepared for cultivation. The marine marshes are not all fertile. Some are bare mud flats without vegetation, while others are covered with a heavy growth of grass and reeds. Such differences are due mainly to the age of the marsh and do not indicate its fertility. The tides deposit such materials as they get, and if the materials are fertile so are the marshes. As a rule those marshes that receive the wash from the hillsides build up faster and are more fertile than those formed by the slow action of the tides alone. If these mud flats were embanked and the tide gates left open, so that the tide would enter, it would greatly accelerate the deposit, and eel grass would soon spring up and spread so as to cover the entire area. This growing grass would retard the coming in and receding of the tide, hastening the deposition of the sediment, and the marsh would soon be built to the elevation of the high tide.

Laboratory examinations show these marshes to be exceedingly rich in the elements of fertility, but possessing from 1 to 5 per cent of soluble matter, mostly salt left by the sea, which must be removed before the land is fit for agriculture. The usual way is to allow the rain to wash out the salt. This is a slow process, but is the one generally followed. The length of time required to complete this treatment depends upon the frequency and amount of rainfall

and the system of internal drainage. The salt must be dissolved in water and that water drained away. This process can be accelerated by judicious irrigation if fresh water is at hand; but flooding, unless the water can be promptly removed, would be of but little use. Where irrigation is practiced, small amounts of water applied at frequent intervals will be found most efficient. While this process of sweetening is going on the salt grass should be frequently cut and removed, as its growth takes up a large amount of saline matter. As fast as the salt is removed, if the land is desired for meadow or pasturage, it should be seeded with tame grass, either herd's grass, red top, or timothy. It improves the meadow to have it closely pastured with sheep or cattle, as it compacts the soil and hastens the destruction of the coarse grass and weeds; but stock has a tendency to fill the ditches, making frequent cleanings necessary, as they must be kept open so as to allow the free flow of water.

If it is desired to put the land in cultivation certain crops that withstand a large amount of salt, as onions, sorghum, and beets, may be cultivated and yield a good revenue. Where a forage crop for cattle is required, sorghum, sowed broadcast and cut just at the time the seed ripens, will be found very profitable.

Salt marsh soils are often well supplied with lime in the form of shells, but when these are not present and the soil is acid, or becomes so through the decomposition of the grass roots, lime must be added to correct this acidity. In all cases it would be wise to send samples of the soil to the Bureau of Soils, United States Department of Agriculture, and have an analysis made to determine the proper treatment.

The best method of subduing a rank marsh soil is not fully determined. In Europe and some parts of America it has been the custom to burn the sod to a depth of 10 or 12 inches. This practice is a great waste of organic matter and is not to be recommended. Clearing the land of all vegetation and giving it a chance to become thoroughly aerated is the first step to be taken. At present the judgment of the farmer must be his guide as to the best method of bringing these marshes into good tilth. In some localities where the practice has been tried it is claimed that the turning under of a heavy green crop in June or July will hasten the rotting of the sod. Others claim that late fall plowing is best and that all vegetation should be removed before turning the land over. In other places it is claimed that better results may be secured by scarring the land with a disk harrow and not turning it over. All, however, are agreed that shallow plowing is more efficient in reducing the sod to a workable state.

CAUSES OF FAILURE.

From a personal inspection in a number of places and the testimony of trustworthy people along the coast where the reclamation of salt marsh has been carried on, the following are noted as the chief causes of failure:

(1) The inefficiency of the dikes because of poor construction from a lack of knowledge as to how to do the work or a false economy practiced in the construction of the same.

(2) The failure of the tide gates to keep out salt water and their lack of capacity to vent the accumulation of fresh water at low tide.

(3) The lack of proper care of the dikes after they are constructed.

In nearly 100 cases of failure investigated the reason assigned was that the "dike went out." Upon a further examination in most cases it was easy to see why the dike went out. It was located too near the shore and was cut away by the action of the water; was too low and was overtopped by the waves; did not have sufficient cross section to withstand the pressure; was built on a poorly prepared base, or was destroyed by muskrats. While the embankment stood, the reclamation was a success and disaster only followed its giving way. (See Pl. XII.) It has been thoroughly demonstrated in many places that an earth embankment will stand if properly constructed, and there is little excuse for failure. Nowhere is the old maxim "whatever is worth doing is worth doing well" more forcibly illustrated than in the building of a dike. Many persons have undertaken this work without knowledge as to how it should be done and have persisted in carrying on a practice that was radically wrong, while others have had but little confidence in the ultimate success of their undertaking and have not been willing to put in sufficient funds to properly do the work. It has been their aim, if after a time the work proved profitable, to enlarge and strengthen the embankment, but this method can not be successfully carried out, because the earth while it is yet fresh, to withstand the action of the water, must be put up in the proper manner and of sufficient quantity. If the embankment is too low and is once overtopped by the waves it will practically be destroyed. If the cross section is too small or has steep slopes it will not withstand the action of the waves and will give way when most needed.

Another reason for insufficient embankments having been constructed is the lack of proper appliances for doing the work. It is only within recent years that dredges have been constructed suitable for this work and where it was put up by hand labor it was difficult, because of the water, to secure the necessary material near the work, and the cost of handling earth in that way made large and substantial

embankments prohibitive in many places, but with the introduction of modern machinery this difficulty is removed and large embankments can now be built at a less price per cubic yard than smaller ones.

Another source of trouble has been the sluices. These have rarely ever been large enough to serve their purpose, and have been put in in such a way that many of them have failed at a critical time, flooding the meadows and thus destroying the work of many years. With the cheapness of concrete construction, permanent structures can now be made at a reasonable cost, and such structures of unquestioned capacity should be constructed in all embankments made. If care is taken to secure a proper foundation such tide gates will be permanent and efficient.

In many places complaints are made of the ravages of muskrats. It is stated that they burrow in the embankment and cause it to give way during periods of high tide. This trouble can be greatly lessened, if not entirely avoided, by keeping the embankment free from a rank growth of vegetation. It should be mowed at least twice a year and the material cut at once removed. This will destroy the harbor for these animals, and the damage they do can be more readily detected and repaired.

Where an embankment is constructed by a number of landowners there seems to be a division of responsibility, and no one looks after it and it does not receive the care necessary for its protection and security.

If instructions given in this report are closely followed as to the location, construction, and care of the embankments there should be fewer failures in the future.

WHY SO LITTLE PROGRESS HAS BEEN MADE.

It has been fully demonstrated by the work done in Nova Scotia and along the Atlantic coast that many of our marine marshes can be reclaimed and made profitable for agriculture. Such being the fact, it is natural to inquire why so little progress has been made in this work. There are many reasons why more work of this kind has not been done, among which are:

(1) To do such work economically it must be carried on upon a large scale. This requires a considerable outlay of money or labor, or both, and the individual ownership of large areas of marsh land or cooperation among several small owners. This outlay must all be made and two or more years elapse before the marsh will yield any returns. American farmers and capitalists prefer, as a rule, to work for results that come more quickly or to invest in securities that are convertible into cash on short notice. This lack of means has held back many persons who are fully aware of the fertility of the land

and convinced of the great profit that would result from its reclamation, but the lack of sufficient funds, together with the knowledge of certain failures that have been made, has perhaps more than any other consideration held back the reclamation of large areas of recognized fertile lands.

(2) In the New England and North Atlantic States nearly all the marsh is owned in small tracts in connection with the highlands, and it is extremely difficult to get the proprietors interested to unite in carrying out any comprehensive plan of improvement. No one holds enough land or has sufficient interest to take the time and spend the money necessary to work up an organization for joint effort. This want of united action among the many owners of small tracts has been a great drawback to the improvement of the marshes along our coast.

(3) Another serious hindrance has been the lack of proper tools with which to do the work. Because of the swampy conditions where the work is to be done and the amount of water encountered, it is both difficult and expensive to construct a large embankment by hand labor. In many localities where the marsh is favorably located and could be reclaimed by a small amount of labor, the lack of information as to how banks should be built and experience in doing the work have held back many owners from reclaiming small tracts of very valuable land. Education along this line of work, the improvement and development of machinery suitable for carrying it on, and the accumulation of capital available for projects of this kind will no doubt remove many of these hindrances and bring about improvement in this work.

RECOMMENDATIONS.

In order to encourage the development of these marine marshes, the Federal Government should be induced to cause a survey to be made to determine their area, character, and fitness for reclamation and the probable cost of doing the work. Such an examination would have a tendency to establish their commercial value and would be of inestimable benefit to both the owners and the Government.

Simple but equitable drainage laws should be enacted by each State having within its borders any considerable amount of salt marsh. Without such a law the progress of reclamation would be slow. It is not right that a few men, owning but a small portion of the marsh, should prevent its improvement and development by refusing to sell or aid in the cost of the work and yet reap the benefits when made by others. Such will, however, always be the case in the absence of just and equitable drainage laws. The drainage of the farms in Ohio, Indiana, Illinois, and Iowa would never have reached such a degree of perfection as they have had it not been for the efficient

drainage laws enacted by the several States. In both Nova Scotia and New Brunswick, where diking is so extensively employed, they have complete statutes providing for their construction and maintenance, and no material progress need be expected in this country until we have such laws enacted.

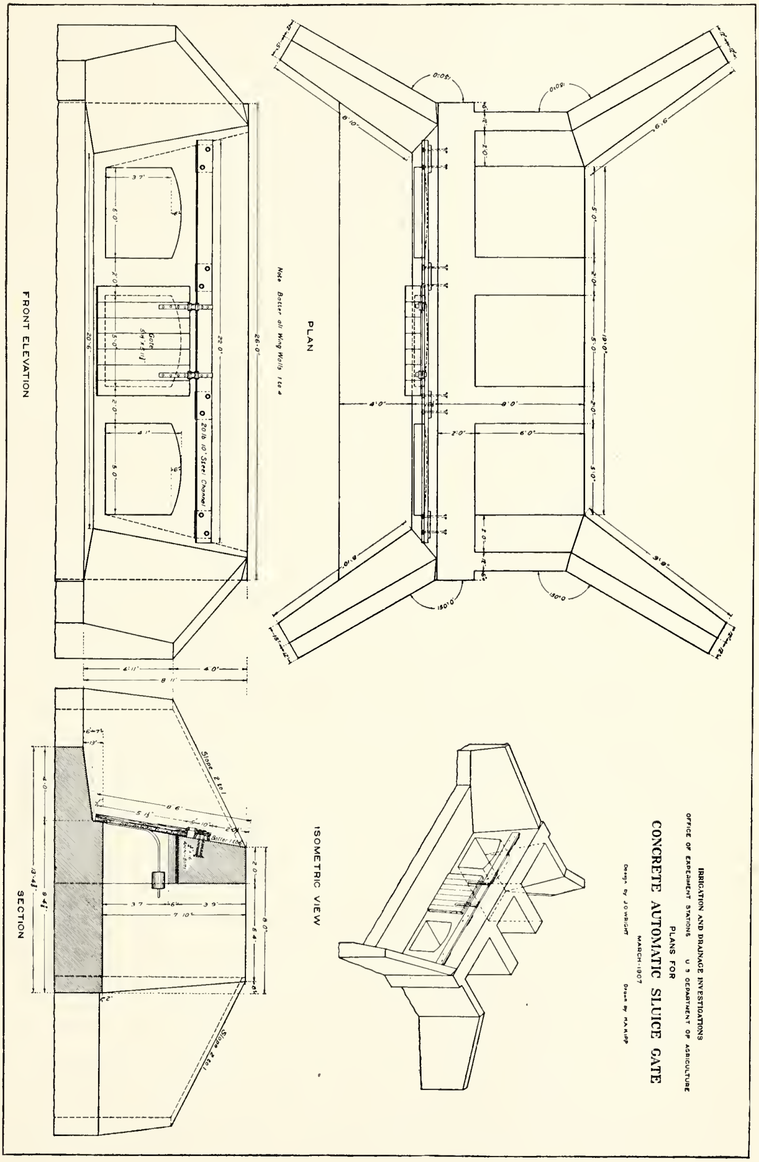
Since our eastern coast has become so thickly populated, any State has, under its police regulations, the power to declare this mosquito-breeding marsh a nuisance and a menace to the public health and compel their abatement, thereby bestowing upon the owners a blessing that they have so long and so persistently refused to accept.

Any State law that would provide for the formation of a district comprising a marsh or series of marshes that could be reclaimed under one plan of improvement and trust the management of its affairs to a board of interested landowners, would be a step in the right direction. Such a law should clearly define the riparian rights of the owners and show the status of such improvement in its relation to the navigation of streams on which such lands are located. It should also make provision for doing the reclamation work as a whole and provide for the issuance of bonds, to be a lien on the lands benefited, to raise money for paying for the work as it is done. These bonds should run for a long term of years at a low rate of interest and be paid in annual installments by a tax on the land reclaimed in the ratio that such lands are benefited by the improvement. Such a law would not work a hardship on the landowners and would enable anyone having unimproved marsh to reclaim the same and pay the cost out of crops to be produced after the work is completed. To further encourage this work the several States should remit the State and county tax on lands thus reclaimed until the cost of improvement has been paid, as the benefit to the State from the increased population and products raised on the marshes will be of more value than the land in its present condition.

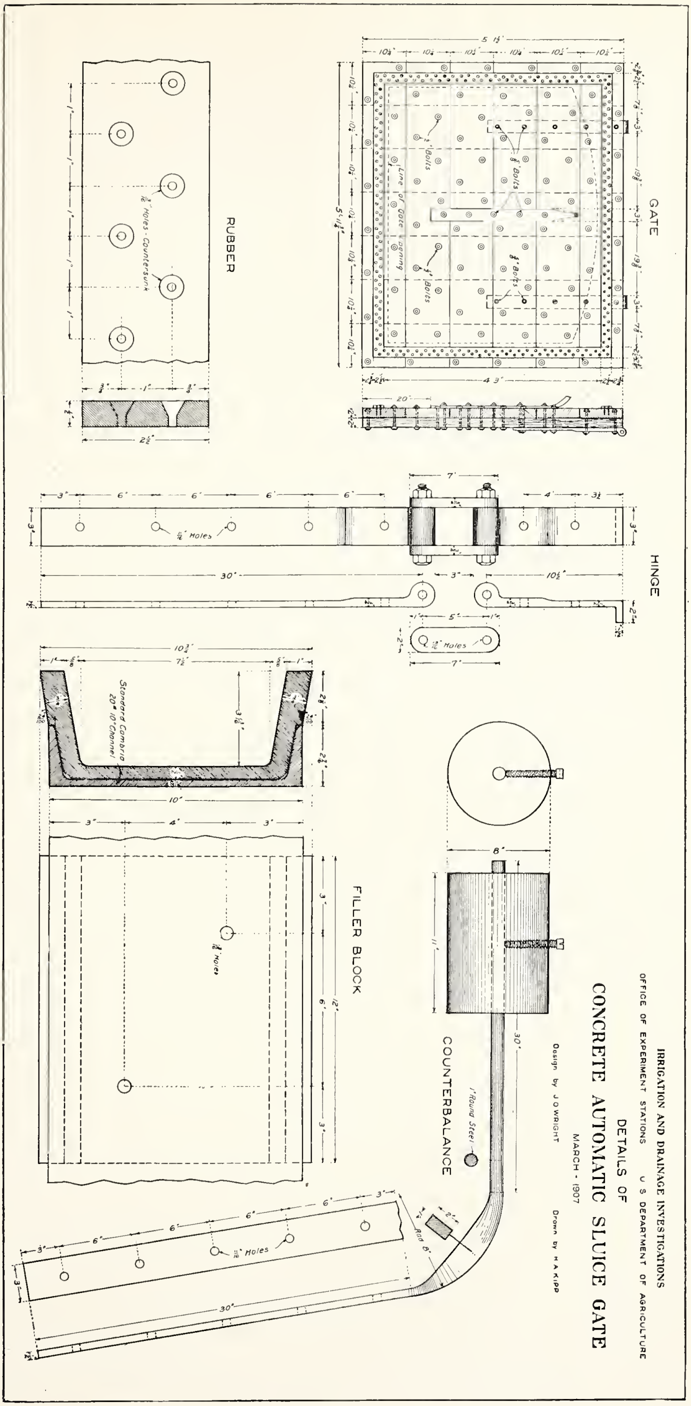
APPENDIX.

Bill of material for a three-chamber concrete sluice gate as shown in Plates XIV and XV.

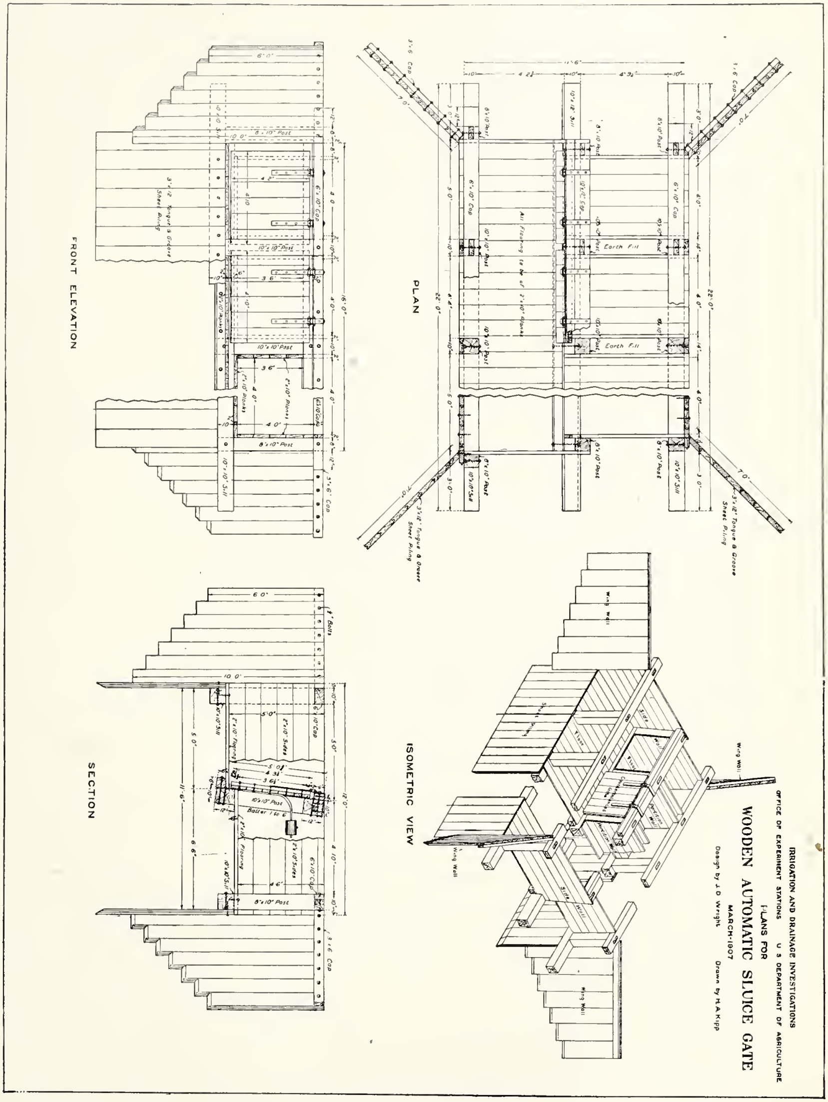
86 cubic yards concrete.
20 pieces creosoted lumber, 3 by 12, 12 feet long, 720 feet B. M.
60 feet 6-ply rubber belting, $2\frac{1}{2}$ inches wide.
750 wood screws $1\frac{1}{4}$ inches long.
255 machine bolts, $\frac{1}{2}$ by 5 inches.
600 wrought washers for $\frac{5}{8}$ bolts.
45 machine bolts, $\frac{5}{8}$ by $5\frac{1}{2}$ inches.
8 T-head anchor bolts $\frac{3}{4}$ by 16 inches
3 counterbalances, as shown on drawing.
6 link hinges, as shown on drawing.
10 square yards cotton duck.
White lead and oakum as required



PLANS FOR CONCRETE AUTOMATIC SLUICE GATE.



DETAILS OF CONCRETE AUTOMATIC SLUICE GATE.



PLANS FOR WOODEN AUTOMATIC SLUICE GATE.

For each additional gate:

17 cubic yards concrete.
7 pieces creosoted lumber, 3 by 12, 12 feet long, 250 B. M.
20 feet 6-ply rubber belting, $2\frac{1}{2}$ inches wide.
250 wood screws, $1\frac{1}{4}$ inches long.
85 machine bolts, $\frac{1}{2}$ by 5 inches.
200 wrought washers for $\frac{5}{8}$ bolts.
15 machine bolts, $\frac{5}{8}$ by $5\frac{1}{2}$ inches.
2 T-head anchor bolts, $\frac{3}{4}$ by 16 inches.
$3\frac{1}{2}$ square yards cotton duck.
1 counterbalance.
2 link hinges.

Bill of material for a three-chamber wooden sluice gate as shown in Plate XVI.

Lumber for frame work:

1 cap, 10 by 12, 20 feet long.
1 sill, 10 by 12, 20 feet long.
2 sills, 10 by 10, 22 feet long.
2 caps, 6 by 10, 20 feet long.
6 posts, 10 by 10, 6 feet long.
6 posts, 8 by 10, 6 feet long.
1 gate beam, 4 by 6, 16 feet long.
1 floor beam, 6 by 6, 16 feet long.
33 pieces sheet piling, 3 by 12, 14 feet long.
25 pieces of flooring, 2 by 10, 12 feet long.
17 pieces siding, 2 by 10, 14 feet long.
2 caps for sheet piling, 3 by 6, 14 feet long.
Total, 3,930 feet, B. M.

Hardware:

28 machine bolts, $\frac{1}{2}$ by $7\frac{1}{2}$ inches for wings.
56 wrought washers for $\frac{1}{2}$-inch bolts.
9 machine bolts, $\frac{5}{8}$ by 17 for floor beams.
9 machine bolts, $\frac{5}{8}$ by 15 for gate beams.
12 machine bolts, $\frac{5}{8}$ by 11 for bent joints.
12 machine bolts, $\frac{5}{8}$ by 10 for bent joints.
84 wrought washers for $\frac{5}{8}$ bolts.
1 keg boat spikes, $\frac{3}{8}$ by 6.

Material for three swinging gates:

$\left.\begin{array}{l}\text{6 pieces, 3 by 12, 14 feet long}\\ \text{9 pieces, 3 by 12, 12 feet long}\end{array}\right\}$ 576 feet B. M
54 feet 6-ply rubber belting, $2\frac{1}{2}$ inches wide.
8 yards heavy cotton duck.
180 machine bolts, $\frac{1}{2}$ by 5 inches.
360 wrought washers for $\frac{1}{2}$-inch bolts.
45 machine bolts, $\frac{5}{8}$ by $5\frac{1}{2}$ inches.
90 wrought washers for $\frac{5}{8}$-inch bolts.
600 wood screws, $1\frac{1}{4}$ inches long.
3 complete counterbalances, as shown on drawing.
6 link hinges, as shown on drawing.
White lead and oakum as required.

EXPERIMENT STATION WORK WITH PEACHES.

By C. B. Smith, *Office of Experiment Stations.*

Of the deciduous fruits in the United States peaches stand second in importance only to apples. According to the United States Census of 1900, apples constitute 55 per cent of the fruit trees grown in the United States, peaches and nectarines following with 27.2 per cent. Nectarines are so closely related to the peach, and are of comparatively such minor importance that the two are classified together in the Census report.

The peach, like the apple, is grown in every State and Territory of the Union except Alaska. The States in which peach growing is an important commercial industry are Michigan, with over eight million trees, Georgia, California, and Texas, with over seven million trees, followed by Kansas, Missouri, Arkansas, Maryland, New York, Delaware, etc., in the order named. The tree itself is quite hardy, being capable, when in a well-ripened condition, of withstanding a temperature of $-20°$ F. or more, while it succeeds in the South much better than the apple. A peculiarity which limits the area of its successful culture for fruit is its early blooming habit. A week or two of warm weather in winter or early spring is often sufficient to swell the blossom buds so that they are easily killed by subsequent freezes, thus putting an end to the crop of fruit for that season. The successful culture of the peach in any locality largely centers around this problem of delaying the swelling of the blossom buds and blooming period until danger from late spring frosts is past.

The fruit of the peach is so delicious that its successful culture excites interest and trial in every locality. Nearly all of the experiment stations have made some investigations regarding this fruit, the results of which have appeared in nearly one hundred separate bulletins and reports scattered over a period of twenty years. This account aims to bring together in brief digested form all the more important data secured in this work along cultural lines, as well as of similar work reported by investigators in other countries. Work with insects and diseases of peaches and the results of tests of varieties are not considered in this review. A large number of the experiment stations have issued bulletins covering in detail the entire field of peach culture in their respective localities. These bulletins are noted by number farther along in this account under the head of literature.

CLASSIFICATION.

In a special report on peach culture in the extreme Southwest by G. Onderdonk, and published by this Department in 1887,[a] peaches are classified into five races, viz: (1) Persian, (2) Northern Chinese, (3) Spanish, (4) Southern Chinese, (5) Peen-to (fig. 8), these geographical names representing the parts of the world in which the race was supposed to have originated or to have reached its greatest development. R. H. Price, of the Texas Experiment Station, practically adopts this classification,[b] giving descriptions and illustrations of a large number of varieties belonging to each of these different races.

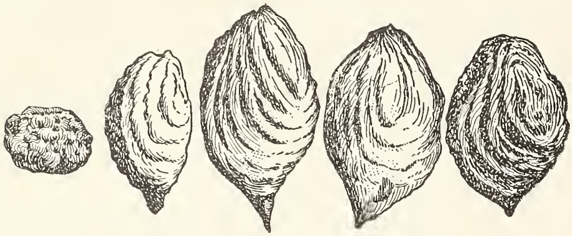


FIG. 8.—Seeds of different types of peaches: *a*, Peen-to; *b*, South Chinese (Honey); *c*, Spanish or Indian (Texas); *d*, North China (Chinese Cling); *e*, Persian (Old Mixon Free).

In the northern peach belt of the United States varieties belonging to the Persian race are chiefly grown, while in the extreme south of the United States varieties of the Peen-to race are the most successful. Between these two extremes the South China, Spanish, and North China races succeed. The following descriptions of the different races, largely taken from Price's account, will serve to point out the differences between them, though a large number of varieties of peaches can not be referred with certainty to any one of the races here given.

1. PEEN-TO (PRUNUS PLATYCARPA).

Varieties of this group (figs. 8*a*, 9) can be successfully cultivated only in subtropical climates, succeeding best in this country in the States of Florida, Louisiana, Mississippi, Alabama, and the coast regions of Texas. The Peen-to variety, which is the parent of this race in America, was first grown in the South by P. J. Berckmans, of Augusta, Ga., in 1869, from seed obtained from Australia. According to H. H. Hume,[c] some twenty-two or twenty-three varieties of this group have originated in Florida, but a much less number is now in cultivation, many of the earlier fruits being superseded by better later varieties. This peach, with its offspring, thrives farther south than any of the other races.

Trees of this group are vigorous, upright in habit, prolific, with willow-like branches and long, narrow leaves. The fruit of the Peen-

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[a] Report U. S. Commissioner of Agriculture, 1887, p. 648.
[b] Texas Sta. Bul. 39.
[c] Florida Sta. Bul. 62.

to variety is much flattened, but with the most of the varieties belonging to the group it is roundish in outline and occasionally blunt pointed. The flowers appear frequently in January in the States bordering on the Gulf, blooming at a low temperature and very irregularly. Price states that the ripening period extends from the 1st of

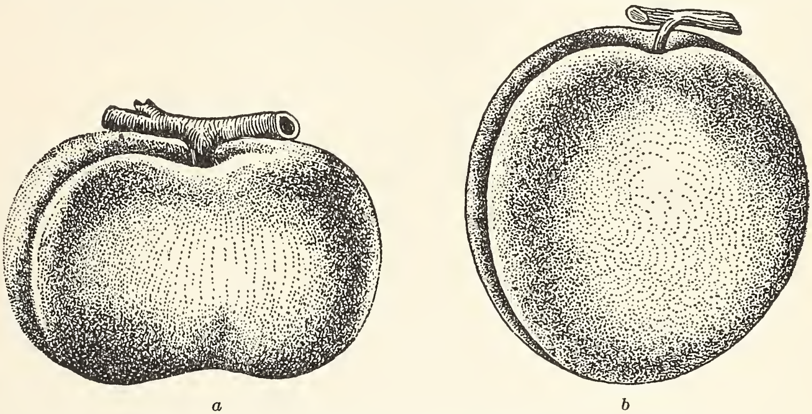

FIG. 9.—Two types of Peen-to race: *a*, Var. Peen-to; *b*, Var. Angel.

May to June in that State, while Hume notes that in Florida it extends from April to the middle of July and a little later, though by far the greater number of varieties mature their fruit by July 1. The varieties Angel and Waldo are placed among the best of this group.

2. SOUTH CHINA RACE (PRUNUS PERSICA).

The parent of this race (figs. 8*b*, 10) is the Honey. This variety originated from seed obtained from China by Charles Downing, stock of which was distributed by P. J. Berckmans, of Augusta, Ga., in 1858. This group seems to be especially well adapted to the central and northern sections of Florida, southern Georgia, Alabama, Mississippi, Louisiana, and Texas. Price gives the following characteristics of the race as grown in Texas:

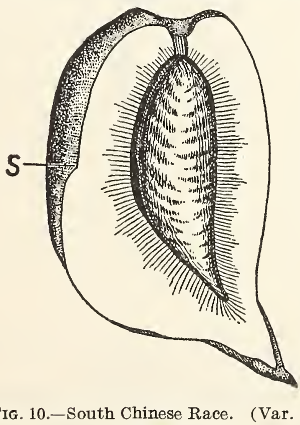

FIG. 10.—South Chinese Race. (Var. Honey.)

> Tree is a medium-sized grower in this climate; branches come out at an angle of about 50° and curve upward; less willow-like than Peen-to; blooms always large and very profuse; the bloom will resist more cold without injury than any class tested here; has borne continuous crops during the past four years while sudden and severe spring freezes occurred. Foliage is small, slightly conduplicate, distributed all along on the limb; color dark green, hangs on late in the fall; requires short season of rest; fruit rather small, somewhat oval in shape;

slightly flattened: suture very deep at basin, but does not extend more than one-third the way; the apex is long and recurved; flavor is a peculiar honey sweet.

According to F. C. Reimer[a] peaches of this group ripen at a season immediately following the Peen-to group. As a group these peaches can endure more cold than the Peen-to and are therefore better adapted to northern Florida.

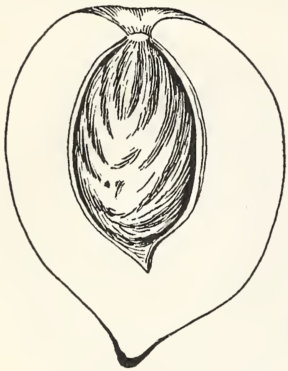

FIG. 11.—Spanish Race. (Var. Texas.)

3. SPANISH RACE.

Onderdonk states that this race (figs. 8*c*, 11) is called Spanish because its history can not be traced to a certainty farther than Spain. It appears to have been introduced from Spain to Mexico about two hundred and seventy years ago by the Catholic missionaries. It is adapted for culture north of the regions in which the South China race flourishes. It is generally believed in the Southern States that seedlings are surer bearers than budded fruit.

Tree very large, except in the Indian type, which evidently has considerable Persian blood, judging from the color of the young wood—which is reddish—the naked places on the bearing wood, and the corrugations and shape of the stone; limbs are large, long, and spreading; branches low and droop down, except in the Indian type; blooms nearly always large; foliage small and nearly always flat; hangs on late in fall, stays green during severe drought; * * * fruit * * * very late, nearly always yellow except in the Indian type, which is always streaked with red or deep blood-red just under the skin; very heavy joint; * * * a heavy bearer and sure cropper in its native zone.

4. NORTH CHINA RACE.

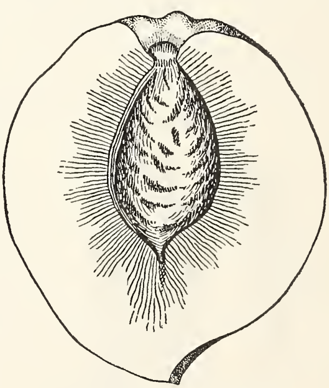

FIG. 12.—North China Race.

The name "Chinese Cling Group" is believed by G. H. Powell to be more exact than "Northern Chinese Race," by which this group is quite generally known (figs. 8*d*, 12). It appears from Powell's accounts[b] that this group of peaches first reached England from China in 1844 and America about 1850. The varieties of this group have originated largely as chance seedlings and are greatly modified in appearance by environment. Powell states that the varieties of this group most largely grown are Greensboro, Carman,

[a] Florida Sta. Bul. 73.

[b] Delaware Sta. Bul. 54.

Thurber, Georgia, and Elberta. Price states that the foliage of peaches belonging to this group is very large and flat and in the Southern States turns a peculiar pea green in the fall, a characteristic which readily distinguishes it from the other groups. In general it is adapted to zones north of those suited to the Spanish race.

5. THE PERSIAN RACE.

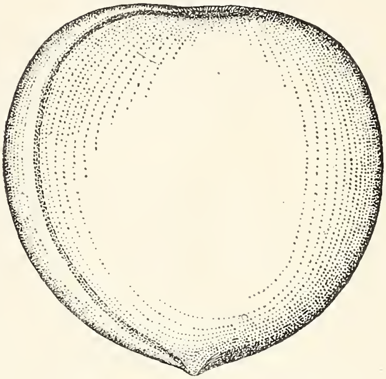

Fig. 13.—Persian Race. (Var. Alexander.)

This race (figs. 8*e*, 13) forms the bulk of Northern peach orchards, and it is practically useless to plant varieties of this race in the southern part of the Gulf States. The fruit is usually highly colored and of the best flavor. Price gives the following description:

Tree medium-sized to large; limbs short and thick, with long naked places; bark usually rich purplish red on young wood; bloom large and small, owing to variety; foliage crimpled and conduplicate, has purplish tinge before falling, foreshadowing the color of the fruit; the foliage falls off early; trees require long period of rest.

TREE GROWTH.

The peach tree is one of the earliest fruits to bloom in the spring and the growth of the branches and wood is practically complete by midsummer. Measurements at the New Jersey Stations[a] of the growth of twigs at different periods during the growing season indicate that about half the growth was complete by the middle of May and about four-fifths by the middle of June, showing that cultivation for the benefit of the tree should be done early in the season, commencing before the time corn is planted.

On rich ground, or when stimulated by late cultivation, excessive rains, or warm weather late in the fall, the season's growth of wood may fail to ripen up well, and the tree thus enters the winter with twigs and branches immature and sappy, a condition almost sure to result in a large amount of winter injury. Nursery stock is especially prone to grow late in the fall.

FLOWER BUDS.

A. L. Quaintance studied the development of the fruit buds of a 4-year old Deming September peach, microscopical preparations being used.[b] There was no indication of flowers when the buds were examined, June 14, but the embryo flowers were found well

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[a] New Jersey Stas. Bul. 197.

[b] Georgia Sta. Rpt. 1900, p. 349.

under way and the calyx lobes quite pronounced by July 23. Stamens and petals were observed by August 23 and the pistils were also indicated at that time.

E. S. Goff, studying the subject at the Wisconsin Station[a] one season, found that the flowers of the Bokara peach commenced forming about the middle of September.

HARDINESS.

As a result of the severe freeze of February 5, 1898, when the thermometer registered $-6.5°$ F., the peach crop of practically the entire South was killed. As a result of an investigation of peaches at this time, the Alabama Station[b] believes that it is not advisable in the central part of that State to plant varieties other than those of the more hardy Persian and North China types.

As a result of an examination of peach buds of six varieties which had been subject during the winter at one time to $-12.5°$ F. and another to $-15°$ F., the Illinois Station found[c] that the variety Wager had but 8 per cent of live buds, Diamond Cling 13 per cent, Alexandra 34 per cent, Thurber 67 per cent, Seedling Cling 77 per cent, and the Roser 83 per cent. An unknown variety growing in sod had 95 per cent of the buds alive when examined at the same time.

Investigations of the Canada Experimental Farms indicate that the buds on the lowest limbs are often more severely injured than those in the top of the tree.[d] Among varieties with the hardiest buds were Hill Chili, Longhurst, Barnard, and Early Rivers.

The Massachusetts Hatch Station reports the results of an examination of peach buds from December 1 until March 13, following.[e] Weekly examinations were made, 500 buds being cut open at each examination. The lowest temperature of the winter was $-6°$ F. From 10 to 99 per cent of the buds on different varieties was killed. Some of the more hardier sorts were Alexandra, Excelsior, Schumaker, Waterloo, and Hale Early. In 1902 the buds were largely killed before the middle of December before the temperature had reached much below zero.

In an investigation of the injury to peach buds from frost, by the New Jersey Stations, it was found[f] that the pistil was the first to show injury, the fresh green appearance being replaced by brownness, and instead of being upright and plump it becomes

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[a] Wisconsin Sta. Rpt. 1900, p. 275.

[b] Alabama Sta. Bul. 11.

[c] Illinois Sta. Bul. 21.

[d] Canada Experimental Farms Rpt. 1896, p. 155.

[e] Massachusetts Hatch Stas. Rpt. 1890, p. 7. Bul. 10, Bul. 17.

[f] New Jersey Sta. Rpt. 1890, p. 323.

shriveled and drooping. The stamens are next to become injured and take on a brownish appearance like the pistil.

"The other less vital organs of the blossom finally die and after a short time become a dark worthless substance. If the bud is not open it requires but a longitudinal cut of the knife to determine the exact condition." With severe injury, however, a pinch of the swollen bud is sufficient to demonstrate that the flower within is blasted and worthless.

PHYSIOLOGICAL CHARACTERISTICS.

The blossoming of the peach is practically independent of root action. L. H. Bailey reports [a] that some of the branches of a nectarine tree standing alongside his laboratory were drawn into the room through a hole made in the window. As a result, the flower buds blossomed on these branches, while the roots out of doors were in frozen ground. The reverse of this experiment was carried out at the New Jersey Experiment Station by Warren.[b] A peach tree was planted in a box and so arranged that the roots were inside the greenhouse, while the top was outside. No growth took place on the outside of the greenhouse, notwithstanding the roots were exposed to a summer temperature. The part in the greenhouse threw out a number of sprouts. Later on, the trunk of the tree was also brought into the greenhouse where it blossomed within a couple of weeks, showing that the exposure of the trunk to winter weather, while the roots were kept at a summer temperature, was apparently without injury.

BLOOMING HABITS.

The California Station has reported a large amount of data [c] relative to the period of blooming, date of ripening, etc., of a large number of varieties. From the very great differences in the behavior of trees often of the same variety and apparently in the same environment, it is concluded that in an abnormal season comparisons between different trees can not safely be made in respect to bloom or leafing, but that the period of ripening is relatively stable. The station has further observed that the varieties that blossom latest are the earliest to ripen. Also that the main crop is more sensitive to February warmth, open their buds more easily, and suffer more from frost.

The notion that early varieties blossom late and late varieties early, was not found to hold true at the Alabama Station.[d] At that station no uniform relation was found between date of flowering and season of ripening. At the New Mexico Station, as a rule, the early peaches bloom later than the late peaches, the date of blooming, however, of varieties varies from year to year, depending

[a] Cornell Sta. Bul. 59.
[b] New Jersey Sta. Bul. 197.
[c] California Sta. Rpt. 1895, p. 391.
[d] Alabama Sta. Bul. 11.

upon the character of the season. A number of the experiment stations have reported data on the blooming and ripening periods of different varieties.[a]

SELF-FERTILITY.

In experiments at the Delaware Station[b] in testing the self-fertility of Old Mixon, Reeves, Elberta, Globe, Crawford Late, and Fox peaches, the self-fertility of the blossoms was found to vary between 70 and 88 per cent, the average being 81 per cent. These fruits may therefore be planted in solid blocks without danger of reducing the yield. Observations by F. W. Fletcher[c] indicate that the variety Susquehanna is self-sterile. In pollination experiments at the Oregon Station in a greenhouse[d] trees to which bees were granted access, set a full crop of fruit, but those artificially fertilized, only a part of a crop, and trees protected from bees and not otherwise fertilized, set no fruit whatever.

WINTER PROTECTION.

In many localities where peaches can not be grown successfully because of severe winter weather or late spring frosts which kill the fruit buds, a method has grown up of laying the trees down upon the approach of winter and keeping them protected until the following spring, when danger from late frosts is past. This method of protection was tested by S. T. Maynard of the Massachusetts Station as early as 1886.[e]

With a frequent winter temperature of $-20°$ F. and destructive late frosts in the spring, the Kansas Station states[f] that peaches fail at that station eight years out of ten. By cutting the roots on one side of the tree and bending it over and letting it rest on stakes, then covering with such material as poor hay, straw, brush, etc., until danger from frost was past in the spring, full crops have been secured. In one test the cost of putting down 71 trees in the fall, including labor and hay, together with the expense of replacing them in the spring, amounted to about 20 cents per tree.

Attempts at this station to protect peach buds by shortening in the head and tying evergreens around the outside, as well as filling in the inside, resulted in failure.

The Illinois Station also reports the successful culture of peaches by laying them down.[g] When the trees were planted, they were set

[a] Texas Sta. Bul. 39; Missouri Sta. Bul. 10; New Mexico Sta. Bul. 30; Oregon Sta. Bul. 34.

[b] Delaware Sta. Rpt. 1902, p. 100. See also Rpt. 1893, p. 150.

[c] New York Cornell Sta. Bul. 181.

[d] Oregon Sta. Bul. 34.

[e] Massachusetts Hatch Sta. Buls. 10 and 17.

[f] Kansas Sta. Bul. 14.

[g] Illinois Sta. Bul. 21.

with the roots extending in two opposite directions. When it came time for laying them down the dirt was dug away from one side of the tree which was then easily bent over and covered with evergreen branches, corn stalks, or coarse straw.

Before bending down the trees at the Missouri Station[a] the main branches were shortened in about one-third of their length, then drawn closely together and fastened with strong twine. After removing the earth from the roots on one side of the tree, the tree was carefully bent over in the opposite direction until it lay prostrate on the ground where it was securely fastened with twine to stakes driven in the ground. Trees thus bent over and covered with straw to the depth of an inch were less subject to variation of temperature during the winter than unprotected trees. In cold weather the trees were warmer, and in warm weather colder than the outside temperature. The labor cost, exclusive of material, it is estimated should not exceed 10 to 15 cents per tree. In none of the experiments recorded has there been any injury resulting to the tree from this practice and normal crops of peaches have been secured.

A variation from the usual method of bending over the trees is reported by the Colorado Station. In many sections there peaches fail four years out of five unless some winter protection is given. The method described and recommended by W. Paddock of that station[b] is to dig a circle of earth about 4 feet in diameter around the trees after the leaves have fallen.

> Water is then poured in and the tree worked back and forth until the roots are loosened and the tree bent to the ground in the direction of least resistance. The branches are then tied together and the tree covered with burlap and held in place with earth. A light layer of earth is then thrown over the tree. As the blossom buds begin to open the following spring, the covering is loosened to admit of light and air, the blossoms are exposed to the sun gradually, and after all danger from frost is considered over, the trees are raised to an upright position and held in place by a couple of props. When placing the trees in an upright position, the ground is again watered and when wet enough the trees are raised without difficulty.

To be successful the practice should be commenced with young trees.

WHITEWASHING AS A MEANS OF WINTER PROTECTION.

J. C. Whitten, of the Missouri Station, reports that he has been successful in delaying the blooming period of peaches from three to six days by whitewashing the trees.[c] The principle involved in this method of protection is that the whitewashed twigs absorb less heat during spells of warm, sunshiny weather than the normal dark colored twigs and branches. The swelling of the buds of peach trees

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[a] Missouri Sta. Bul. 16.
[b] Colorado Sta. Bul. 80.
[c] Missouri Sta. Bul. 38.

was found to be practically independent of root action. Warm weather may produce growth in the buds whether the ground is frozen or not. Even zero weather may kill fruit buds if they have been swollen previously by warm weather or were not properly ripened in the fall.

In the station experiments the whitened buds remained practically dormant until April, while unprotected buds swell perceptibly during warm days late in February and early in March. By the use of whitewash about 80 per cent of the buds came through the winter safely, while on the unsprayed trees only 20 per cent passed the winter unharmed. Thermometer tests showed that when the buds were covered with green, purple, or black material, the temperature in bright sunshine was from 10° to 15° higher than when the buds were covered with white material.

The most efficient whitewash was made from lime with one-fifth skim milk added to the water and 1 pound of salt per bucket full. The whitewash was applied with a spray pump, four sprayings being given during the winter and spring. Two sprayings were given at the beginning to insure whitening. About half a bucket full of whitewash was used per tree at each spraying. The entire expense of the four sprayings Professor Whitten states may not exceed 10 cents per tree.

MISCELLANEOUS METHODS OF WINTER PROTECTION.

Cornstalks have been used at the Missouri Station[a] as a winter protection for peach trees. The limbs of the trees were first drawn together with a rope, then covered with cornstalks and the whole bound into a bundle. The covered trees blossomed two days later and remained in bloom several days longer than unprotected trees. Some of the trees were uncovered at blooming time and others later, one tree being left until nearly three weeks after blooming. The fruit had set well under the cover, except near the top where the limbs were joined closely together. With young trees this protection is about as easily and cheaply applied and about as effective as whitewash, but can not be used as readily with old trees. The use of canvas or hay caps have also proved to be as effective at the station as whitewash or covering with cornstalks. The method is probably too expensive for old trees.

The most effective protection at the station was secured by erecting board sheds over the trees. Posts were set at the outer ends of the branches and rafters placed on them to meet over the center of the tree. Fence boards were then fastened an inch apart on the top and part way down the sides. Trees thus protected set fruit very well, and were not severely injured by either the cold of winter or the hot,

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[a] Missouri Sta. Bul. 38.

dry winds of spring. Thus protected, the trees blossomed later, remained in bloom longer, and set much more fruit than any other trees of the same varieties in the orchard. The sheds were left over the trees until the middle of May. Practically no fruit dropped from the protected trees, while a good deal dropped from the unprotected ones. The cost for lumber was about $2 per tree, and the cost of building and taking down the sheds 80 cents.

The use of such materials sprayed on peach trees as glue, turpentine and benzine, benzine and rosin, benzine and hard-oil finish, linseed oil and turpentine, shellac, etc., proved of no benefit whatever as a winter protection at the Massachusetts Hatch Station,[a] while materials containing turpentine and benzine killed the trees. At that station also,[b] where the winter temperature varies from −16° to −28° F., bending over the trees and protecting with mats or other light coverings of moss or pine boughs prevented the destruction of the buds, and the treatment did not injure the trees.

CAUSES OF WINTER INJURY IN PEACH ORCHARDS.

Great losses are suffered in peach orchards during what are known as test winters. The prolonged winter of 1903–4 resulted in great losses by orchardists in the Lake Erie peach belt of Ohio. Some orchards were entirely destroyed, others were apparently uninjured, and still others, while suffering severely, yet contained sections, rows, or parts of rows, or individual trees that came through the winter uninjured. A careful study of affected orchards by the Ohio Station[c] showed that while the general or direct cause of the injury was, of course, the severe and long continued cold, the specific causes of the varying degrees of injury were many.

Of course, some varieties of peaches are much more susceptible to injury from cold than others, and during a specially severe winter these will naturally suffer most. Aside from these losses, however, many additional losses occurred among the hardiest varieties. The causes of the injury in different orchards and of the varying degrees of injury in the same orchards were found to be exceedingly numerous. Generally speaking, wherever the vitality of the tree or orchard had been lowered by any cause whatever during its previous history, the chances of injury to the tree by cold were so much increased. Thus, trees in low vitality, due to lack of fertility or poor physical condition of the soil, trees weakened by attacks of San José scale, leaf curl, borers, etc., an extremely dry condition of the ground, very wet soils, trees on poor soils, especially soils lacking in humus, were in every case the ones most seriously injured by the unusually severe winter.

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[a] Massachusetts Hatch Sta. Rpt. 1888, p. 15.
[b] Massachusetts Hatch Sta. Bul. 17.
[c] Ohio Sta. Bul. 157.

As showing the value of some kind of a mulch as a winter protection, the station reports that in one instance the ground froze to a depth of 18 inches on bare soil, while under a thin covering of grass and weeds it froze to a depth of only about 8 inches. On the bare soils the trees the following spring started into growth slowly, and many of them were seriously injured, while the trees in sod suffered no apparent injury, all making a healthy, uniform growth.

In orchards which had been given clean cultivation throughout the season the injury was much greater than where cover crops were plowed under each year. Trees which had received even a light dressing of stable manure within a year or two suffered noticeably less from the cold. In one instance a grower was able to protect his trees by banking a few fork fulls of either manure, peat, or earth around the base of the trees, while the trees left without this simple treatment died almost to a tree.

In order, then, to avoid to the greatest extent winter injury the investigations of the station brought out clearly the necessity of such continuous and thorough cultural practices in the orchard as shall maintain the trees at all times in a vigorous, healthy condition. The fertility and vegetable matter of the soil must be maintained by the addition of manure or the growing of cover crops; and spraying to control insect pests and fungus diseases must be thorough and unremittent.

TREATMENT OF WINTER-INJURED TREES.

A number of stations have carried on experiments in the treatment of winter-injured peach trees with the hope of saving them and bringing them into normal bearing again.

At the New York State Station[a] an attempt was made to distinguish between the trees which were fatally injured by cold and those which might be expected to recover. It was thought at first that the amount of discoloration of the wood of the tree would indicate the extent of the injury, but this was found not to hold true. In one instance, wood of peach trees below the snow line when examined in March was sound and of normal color, but above this line the bark though tight on all portions of the tree was very dark brown all through and the trunk wood was black. On the limbs, the bark and wood was discolored as high up as a man could reach. These trees completely recovered and made a good growth of wood during the season, though none of them bore fruit. The next season every tree was in good condition and bore a good crop of fruit.

In another orchard of old peach trees the bark on the trunks of the trees could be easily peeled off the wood, and these trees were thought to be dead beyond all question by all who examined them. For the

[a] New York State Sta. Bul. 269.

most part, however, they produced a good crop of healthy, well-sized, well-colored foliage and made a very fair recovery. The observations with peaches and other fruits indicate that it is extremely difficult to tell by any ordinary method of examination the real condition of trees at the end of a winter season and their ability to overcome winter injury.

Experiments were made by the station in pruning back the winter-injured trees to different degrees as a means of rejuvenation. Some trees were given a moderate amount of pruning, some were not pruned at all, others were cut back to the large limbs or ''dehorned,'' and in some instances, young trees were cut off below the snow line. In the station experiments when peach trees 7 or 8 years old or older were cut back to where the limbs were 1½ to 2 inches in diameter, or ''dehorned,'' they failed to recover, and by the following September all were dead.

On the other hand, young peach trees 2 to 5 years old thus treated made a splendid recovery, and trees thus pruned back in January made a better growth than when the cutting back was deferred until March. Young trees in the same orchard not pruned at all either died outright or the new growth was mostly in the top, making an undesirable tree. One of the objections to pruning young peach trees back so severely was that it induced a too great growth of young wood which formed a bushy top and necessitated a great deal of additional pruning.

In the orchards of both old and young trees a moderate amount of pruning back was compared with no pruning and with ''dehorning.'' Trees moderately pruned made in every instance a much better growth than those not pruned at all. Old trees which died when ''dehorned'' recovered when only moderately pruned.

Much the larger number of injured trees were not pruned at all, and, while many of these made a recovery which was satisfactory to the grower, it was evident that the average condition of these trees was not nearly so good as when they were given a moderate pruning. The young pruned trees contained a much larger amount of dead wood and the new growth was much more generally at the extreme ends of the branches, which made the top of the tree too spreading.

The Michigan Station also reports[a] that severe pruning of winter-injured trees—that is, cutting back to wood 1½ to 2 inches in diameter—proved dangerous to the life of the trees. Moderately pruning, or cutting back to wood one-half to three-fourths of an inch in diameter, gave better results than light pruning in the usual way. It appears that in the Michigan experiments trees lightly pruned after the usual plan of heading in and thinning out part of the new growth, grew more slowly, produced smaller, less thrifty foliage, smaller fruit

[a] Michigan Sta. Bul. 177; Bul. 187; Spl. Bul. 11.

of poorer quality, and contained more dead wood than the trees pruned moderately severe. In these experiments the pruning was done at intervals of ten days between April 1 and May 1. No variation in the growth of the trees that could be ascribed to the difference in time of pruning was observable.

F. A. Waugh, at the Massachusetts Hatch Station reports[a] better results in moderately pruning back winter-injured trees than either no pruning or "dehorning."

In experiments with injured trees at the Missouri Station, J. C. Whitten found[b] that trees of bearing age which were cut back into 2-year-old wood, in the case of young trees and to 3 or 4 year-old wood in older trees, thus leaving stubs of the main limbs from 3 to 4 feet long, made the best growth. With young trees only 2 years old the best results were secured in cutting them back so as to leave only the trunk and spurs of the main branches 2 or 3 inches long. With 1-year-old trees, cutting back nearly to the original bud and training up a single sprout resulted in fine trees. Trees that were cut back into more than 4-year-old wood failed to grow in many cases, showing that in very old wood the buds are too dormant to be easily started into growth. As at the Michigan Station, equally good results were obtained in pruning trees any time after the severe cold of winter up to the time the buds begin to start in the spring. Good cultivation is believed to be of more than usual benefit to peach trees during the spring and summer following severe winter injury.

Somewhat different from these results are those reported by the Arkansas Station,[c] where trees severely winter injured by a temperature of $-26°$ F. were saved by severe pruning back, and produced a heavy crop in 1902, while orchards not treated produced nothing and were in a feeble, dying condition. Trees lightly cut back were not so satisfactory as those heavily pruned. This appears to be an exceptional result.

In concluding this phase of the subject, the recommendations of M. B. Waite,[d] of this Department, may be taken as succinctly stating the treatment to give winter-injured peach trees. These are to the effect that when peaches are injured by freezing so that the bark is entirely blackened, dead, and more or less separated from the trunk, and the wood turned a very dark brown color, the trees are probably dead beyond all question and should be treated accordingly. If, however, the bark is only slightly separated from the wood and only somewhat browned and discolored, the wood of the trunk being

[a] Massachusetts Hatch Sta. Rpts. 1904, p. 166, and 1905, p. 47.
[b] Missouri Sta. Bul. 55.
[c] Arkansas Sta. Bul. 79.
[d] U. S. Dept. Agr., Bureau of Plant Industry Bul. 51, pt. 3.

blackened throughout, many such trees will have enough vitality to enable them to pull through. Others of less vitality are likely to succumb. If the trees are only moderately frozen, the wood above the snow line being blackened but the bark not separated from the wood and with the cambium still apparently alive, though water soaked and injured, they will almost invariably recover.

Trees thus moderately frozen, even though the wood is blackened throughout, may be expected to yield abundant crops for several years in the future. In the case of trees where the wood is blackened and dead clear to the bark, moderately pruning back from one-third to not over one-half of the top will give the best results. No pruning at all will give better results than too severe pruning.

Such trees if cut back to the large branches or "dehorned" are generally killed by this too severe pruning. Generally speaking, "almost all the trees in which the bark is stuck tight at the critical point—about 2 feet from the ground—may be expected to pull through, and many which have the bark partially loosened may recover. Moderate pruning back, followed by good cultivation, and unless the land is in very good condition with a moderate amount of fertilizing, will be the best course to pursue."

PROPAGATION.

Peaches are propagated from seed, the important varieties being perpetuated by either budding or grafting on seedling stock. Some varieties of peaches come practically true from seed. At the Alabama Station [a] seedling peach trees from selected seed were planted in the orchard in comparison with budded varieties. The fruit of the seedlings was very inferior, and all matured within a month, while fruit from budded trees was obtainable from July 6 to October 15. The statement that seedling trees often bear fruit when budded trees fail was not found to hold true in these experiments.

The Delaware Station also reports [b] that pits obtained from Tasmania where yellows was not prevalent produced trees in Delaware as subject to yellows as native seedlings. That station also found [c] that pits in which the kernels were loose and rattled when shaken germinated as well but no better than pits which did not rattle. The opinion of T. V. Munson is quoted by the station with approval to the effect that a rancid kernel with discolored flesh always contains a dead germ, and that seed over 1 year old is worthless. Prime seed should give 95 to 98 per cent germination. From 40 to 60 per cent of seed 1 year old planted early in the winter so as to become well frozen should germinate.

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[a] Alabama Sta. Bul. 11. [b] Delaware Sta. Rpt. 1893, p. 152. [c] Ibid., p. 143.

In a later work the New Jersey Station found that pits from natural seedlings are more vigorous than pits from improved varieties. In one experiment[a] from 620 pits from seedling trees 108 trees were secured, while from 321 pits of improved varieties only 7 trees were secured. Wherever natural pits can be obtained stock pits from the canning house should not be used. Peach seed is usually stratified and subjected to the action of frost before planting, otherwise it should be cracked.

The Kansas Station[b] has made observations on the character of trees produced by peach pits containing two embryos as compared with those containing only one. In some cases the two trees are so nearly alike as to make it difficult for inspection of minute details in order to distinguish them, while others were quite noticeably distinct.

Budding is easier and more successful with peaches than grafting. In the North, seedling stock 1 year old is budded anywhere from the latter part of August to the first week in October. June budding is practiced in the South with fair success, but in the North such buds make a weak, late growth that is likely to be injured by a severe winter.

The Texas Station describes a successful method of budding peach trees late in the fall when the bark will not slip.[c] The method is an old German one, but was worked out independently by the station.

It consists of cutting a slip of bark, with some wood attached, down the tree about 1 inch, leaving it attached at the lower end. About half this slip is then cut off, leaving the other half still attached to the tree. Cut off a bud, leaving some wood also attached to it to prevent injury, and then carefully place it between the slip and tree so that it will fit nicely and the cambium of the bud and tree come in contact. Tie tight with some good material, such as raffia. In five or six days the bud will be found to have knit firmly. Treat them then as those budded in the usual way.

STOCKS FOR THE PEACH.

The peach usually gives best results on peach stock. At the California[d] Station peaches on almond stocks made fairly large trees. Peaches on Myrobalan stocks fruited earlier than on peach stocks, but were dwarfish and unsatisfactory on the soil used. At the Kansas Station[b] 47 trees were budded on peach stock and 44 on Myrobalan. Six years later 24 of the trees on peach stocks were sound and vigorous, while all peaches on Myrobalan were either dead or in very poor condition.

N. E. Hansen reports[e] out of 56 grafts made with the Bokhara peach on sand cherry stock (*Prunus besseyi*) only 1 grew. Much better success was secured in budding on this stock. The tree is

[a] New Jersey Sta. Bul. 197.
[b] Kansas Sta. Bul. 73.
[c] Texas Sta. Bul. 39.
[d] California Sta. Rpt. 1896–97, p. 391.
[e] South Dakota Sta. Bul. 87.

dwarfed in size and fruits early on sand cherry stock. The fruit is fully up to the standard in size and quality. This stock is especially recommended by Hansen to those who grow peaches in houses and for dwarfing purposes generally. E. S. Goff also reports the successful use of the sand cherry as a stock for the peach [a] and believes it may be especially useful for growing dwarf trees that may be easily laid down winters as a means of winter protection. He reports that at the end of the second year trees on this stock had attained a height of about 5 feet, but this appears to be practically the limit of height growth.

LOCATION OF THE ORCHARD.

Owing to the early blooming habit of the peach it is generally recommended that it be planted on rather high ground to provide good air drainage away from the trees. In this way many local frosts are avoided. Planting on northern slopes or in the immediate vicinity of large bodies of water also tends to delay blooming.

In the reports on winter injury to peach trees a number of the stations have noted that trees located in pockets where cold air settled were usually the ones most seriously injured. At the Nebraska Station R. A. Emerson reports [b] that on high lands peaches at the station have uniformly ripened up their wood much earlier in the fall than those grown on low land and have come through the winter in much better condition, and that frequently the trees on low lands have been killed or greatly injured when those on high lands have come through with only slight discoloration of the bark.

SOILS.

L. H. Bailey [c] reports that some of the best peach orchards he has known have been located upon sandy lands so poor that they were once thought to be worthless. In New York the peach orchards which are giving the best returns are located on the warm sandy lands along the Ontario shore. While peaches will thrive upon heavier lands, often upon clay, they are rarely so productive upon these heavy lands unless severely headed in. On heavy lands the trees run more strongly to wood and often split down from the weight of the foliage alone when disturbed by the wind.

In the report on field operations of the Bureau of Soils of this Department for 1901 [d] it is noted that peaches were an important crop on 9 per cent of the stony loam, 24 per cent of the sand, 55 per

[a] Garden and Forest, 1896, p. 448.

[b] Nebraska Sta. Bul. 79 and Rpt. 1896, p. 109.

[c] New York Cornell Sta. Bul. 74.

[d] U. S. Dept. Agr., Field Operations Bureau of Soils 1901 (3d report).

cent of the fine sand, 12 per cent of the sandy loam, and 2 per cent of the loam examined, and were not reported as an important crop on any of the other classes of soil, thus confirming the general impression that peaches are adapted to the loose open soils of a sandy nature and to some stony loams.

In a bulletin from the Arkansas Station it is reported[a] that much of the land on which peaches are now successfully grown in the South is worn cotton soil. The roots of the peach tree reach deeper than cotton and draw on stores of plant food untouched in the shallow culture of that plant.

At the Mississippi Station[b] peaches grown in a stiff, heavy clay over light-colored, sticky, and poorly drained subsoil made a rather unhealthy growth. A large percentage of the trees died and the fruit lacked color and flavor. On a deep, strong clay loam over an orange-colored clay subsoil the trees grew rather too vigorously and it was difficult to keep the wood growth within proper limits. On light, gray-colored soil the trees were medium sized, required but little pruning, and produced a fair amount of fruit of good quality, but showed signs of nearing the end of their period of usefulness after four years bearing. On red clay over deep red subsoil the trees were medium sized, healthy, well shaped, and required but little pruning. The fruit on these trees was invariably more highly colored, freer from defects, and more uniform in size and shape and more highly flavored than that from other parts of the orchard.

The California Station reports[c] that no peaches of even fair quality have been produced at the station on strong alkali. On black alkali the fruit on some of the peach trees dried up when it was the size of a walnut. Peaches on light alkili showed a tendency to overbear beyond the normal rate of young trees, but the fruit was of only medium quality. Such data as have been secured favors the use of plum stocks on alkali soils. Strong alkali soil is relatively cold and it has been noticed that on such soils the blossoms and leaves often appear five or six days later than on ordinary soils.

TREATMENT OF TREES AT TRANSPLANTING.

The experiment stations quite generally recommend strong, healthy trees 1 year old from the bud for transplanting to the orchard. There is a difference of opinion as to how the trees should be pruned with reference to roots and branches at this time. H. M. Stringfellow in his book on the new horticulture and in numerous communications to the agricultural press advocates that in setting out trees the roots should be pruned back to mere stubs and the top of

[a] Arkansas Sta. Bul. 79.

[b] Mississippi Sta. Bul. 93.

[c] California Sta. Rpts. 1891–92, p. 206; 1893–94, p. 407; 1896–97, p. 397.

the tree cut back to about 12 or 18 inches, thus making practically a cutting out of the tree. Thus treated, the trees can be set by making the holes with a crowbar and firmly tamping the earth around the base after setting. It is claimed by Stringfellow that by this method of treatment the roots of the trees will take a more downward course and would thus be less subject to varying influences of heat, drought, and cold, and a more vigorous, longer lived tree would result.

This method of pruning trees and various modifications of it have been tested at a number of experiment stations. At the Delaware Station [a] Powell cut the roots of one lot of peach trees back to 8 inches, those of another back to 3, and those of a third lot were "cut back just below the collar and just under the first good side roots." The trees thus treated were planted in a heavy, well-drained clay loam with a stiff subsoil 8 or 10 inches below the surface and the experiment was duplicated on a warm, well-drained sandy loam with a stiff subsoil 2 feet below the surface.

On the clay-loam soil practically all the trees with the roots pruned back to 8 inches or 3 inches lived, while of those pruned back to stubs only a little over one-half lived, and none of these were first-class trees. On the sandy-loam soil practically all the trees lived by whatever method of pruning, but of those pruned to stubs only about 11 per cent formed first-class trees, while when the roots were left from 3 to 8 inches long practically all were first-class trees.

In another experiment on warm, well-drained sandy loam 16 out of 20 trees pruned according to the Stringfellow method lived and made a growth equally as good as trees root pruned according to methods usually followed. From these experiments Powell concludes that "a tree without roots may be able to put forth a new system and make as good a tree as any other on moist quick-acting sandy loams."

It was further shown in these experiments that "stub-pruned trees are at a disadvantage in ground that freezes solidly throughout the winter, in a dry fall or spring, or in a cold soil." The root systems of the stub-pruned trees in these experiments did not take a more downward direction than those not pruned at all, or those pruned 8 inches or 3 inches. Similarly with the tops of the trees the branches were found to start anywhere along the trunk from near the ground to the top or from one side, and it is concluded that the stub-pruning system is not one of universal application, but one of local merit on warm, moist, mellow soils. It is recommended that Delaware orchardists prune the roots of fruit trees in setting back to 3 or 5 inches in length. "Shorter roots present no emphatic advantages and longer roots are useless and expensive to set in the ground."

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[a] Delaware Sta. Bul. 45

The Stringfellow method of root pruning has also been tested at the Georgia Station,[a] the trees being planted in red loam with a stiff red-clay subsoil. At this station it was found that the best root systems were secured when the roots had been cut back to 1-inch taps. The roots from these trees penetrated to a greater depth than in any other system, but in no case did they penetrate perpendicularly, as claimed by Mr. Stringfellow. H. N. Starnes, who conducted the experiment, concluded that he is fairly satisfied that peach trees prunded by the Stringfellow method will live and flourish in that section even in stiff clay soil and under adverse meteorological conditions. In these experiments little difference, if any, was observable between the rows whose tops had been pruned back to 12, 18, or 23 inches, respectively, all branching equally low.

H. W. Collingwood reports [b] that he planted peach trees in New York by cutting the tops back 12 to 15 inches long and removing all side roots so as to leave a stem below ground as smooth as a lead pencil. These trees were set in light sandy soil which had not been plowed for thirty years and was in part so poor that only a few coarse weeds would grow on it. This field was not cleared and the holes for setting were made about 10 inches deep with a crowbar. A little sand was then put in and then the peach tree. More sand was put about the tree, water poured in and the hole filled up with earth, packing it firmly around the stub thus planted. Thus treated the trees made a satisfactory growth, but it is recommended that for practical purposes stubs should be left on the roots 1 to 2 inches long. This anchors the tree more firmly to the soil and thus prevents it from being whirled about by the wind or lifted by frost.

In a trial of the Stringfellow root pruning method at the Alabama Station [c] with eight varieties of peaches neither increase nor decrease of vigor in growth could be detected as a result of the practice. At the Arkansas Station [d] stub-root pruning was less satisfactory than moderate pruning of the roots. Likewise at the New Jersey Stations [e] results were considerably in favor of trees root pruned in the usual manner. At the Texas Station [f] Price states that "without drawing positive and definite conclusions, it seems evident so far as this soil and climate are concerned that severe top and root pruning are not advisable." The best results at that station have been secured by pruning the top of young trees down to about 18 or 20 inches and the roots back to within 6 inches of the trunk.

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[a] Georgia Sta. Bul. 40.

[b] Rural New Yorker, 63 (1904), No. 2824, p. 206.

[c] Alabama Sta. Bul. 98.

[d] Arkansas Sta. Bul. 79.

[e] New Jersey Stas. Rpts. 1900, p. 253; 1901, p. 253.

[f] Texas Sta. Bul. 39.

In this connection it may be stated that in the Hale orchard of 100,000 peach trees in Georgia the trees were root pruned according to the Stringfellow method and have given entirely satisfactory results. Reviewing all the data available, it would seem that in certain localities, particularly on warm, moist, loamy soils, the stub-root method of pruning back the trees may give entirely satisfactory results, but station evidence is generally in favor of less severe pruning. It has been clearly shown, however, that leaving on all the long roots of peach nursery stock is unnecessary and useless.

CULTIVATION AND COVER CROPS.

During the first two or three years after the trees have been set in the orchard the space between the rows can safely be planted with low-growing crops, leaving a space alongside the trees for cultivation and restricting more and more the area devoted to crops with the increasing age of the orchard. It is generally agreed that after about four years, when the trees come in bearing, no crop should be grown, but the whole orchard space given to the trees.

The fact that peaches do not bear some years is taken as an excuse sometimes for not cultivating the orchard that year. This is a serious mistake, because the flower buds of the following crop are produced during that year. Any lack of attention or cultivation directly influences the crop of fruit and the neglect results in injury to the tree. By the work of borers, scale, or diseases trees may be so weakened that they may fall an easy victim to any unusual severe weather the following winter. The New Jersey stations cite an instance[a] in which the fruit buds of all the fruit trees in an orchard were killed one winter, as the result of which the grower left the trees in sod and cut hay in the orchard the following summer. At one end of the orchard, however, several rows of trees were tilled and planted with potatoes. The following year the entire orchard was well tilled and cared for but it was too late for the best crop. The part that had been tilled the previous summer gave six times as many peaches as the part that was not tilled.

The tenderness of the peach makes it very desirable that cultivation be such as will tend to encourage the ripening of the wood of the tree before winter sets in. This is facilitated in a large measure by the planting of crops in the orchard about midsummer which, by their growth, will evaporate the soil moisture and utilize the plant food to such an extent as to discourage any excessive growth of the trees in the fall and bring about a well ripened condition of the wood. U. P. Hedrick has shown[b] that there is an intimate relationship between various herbaceous plants used as cover crops and the peach.

[a] New Jersey Stas. Bul. 197. [b] Rural New Yorker, 43 (1904), No. 2862, p. 858.

In pot experiments, he found that when certain plants like oats, blue grass, mustard, or potatoes were used as cover crops for seedling peaches the trees ripened their wood long before there was sufficient frost to injure the foliage. When, however, such plants as crimson clover, peas, and beans were used as cover crops the leaves remained on the trees green and luxuriant until killed by severe frost November 1. These leguminous plants proved a perfect failure so far as ripening the wood and preparing the trees for winter were concerned. An examination of the root growth in the pots showed that the root systems of the trees and the plants in the case of the nonleguminous group were not at all intimate, but in the case of the clover and the peaches the roots were so intermingled that they matted together and could not be easily separated. From a practical standpoint, therefore, where the object of the cover crop is to hasten the maturity of the tree, cereals would probably prove much more effective than legumes, especially crimson clover. These results suggest a line of work with cover crops that might prove very useful to peach growers.

At the Nebraska Station[a] the use of cover crops induced the peach trees to ripen up from a few weeks to two months earlier than trees given continuous cultivation throughout the season. At that station and in other Western States it is very desirable that the ground be well filled with moisture when freezing weather comes on, as the trees continue to evaporate moisture throughout the winter. On this account it is desirable to use a cover crop that will be killed by the first severe frosts of the fall, otherwise its continued growth would result in drying out the soil, so that moisture available for the tree during the winter would be reduced below the danger limit. The crop should also be such as will stand up well during the winter to catch and hold the snow in order thus to prevent deep freezing of the ground and to retain as much moisture as possible. Millet has proved exceptionally well suited as a cover crop at that station for these various reasons.

In experiments in mulching at the California Station[b] the application of a mulch of fresh barnyard manure early in the season served better for conserving moisture than did a mulch of cultivated earth.

WINTER IRRIGATION.

A. J. McClatchie found that better results are secured with peaches and apricots in the irrigated regions of southern Arizona[c] if the orchard is irrigated in winter when water is abundant and the trees dormant than if the water is applied only during the growing season. Peaches and apricots made branch growths of 3 to 6 feet per season

[a] Nebraska Sta. Bul. 79. [b] California Sta. Rpt. 1895, p. 401.
[c] Arizona Sta. Bul. 37.

and produced heavy crops of excellent fruit when 3 feet of water was applied to the orchard in winter and none whatever applied throughout the growing season of six to eight months, except the limited rainfall.

Roots were found in abundance at a depth of 12 to 16 feet and many were found beyond 20 feet. It is due to this fact that sufficient water can be stored in the soil in winter to carry the trees through the summer without irrigation. The roots were found growing at the tips a full month before there were any signs of growth above ground. Winter irrigation for locations having climatic conditions similar to the station is recommended. About 3 feet of water should be applied, and if cover crops are grown in the orchard, 4 feet.

FERTILIZING PEACH TREES.

A number of the stations have investigated the fertilizer requirements of the peach. At the New Jersey stations records were kept[a] to determine the amount of plant food removed from the soil by a peach tree, during ten years' growth. Each year the leaves were saved from the tree and weighed and analyzed. All the prunings and all the fruit were also weighed and analyzed. Finally the tree was removed, roots carefully dug out, and the wood and roots analyzed. The total weight of the leaves and fruit for the ten years was 616 pounds, of which 2.85 pounds was nitrogen, 0.76 pound phosphoric acid, and 1.69 pounds potash. On an acre basis, with the trees 16 by 15 feet apart, this would represent a withdrawal from the soil of 516 pounds of nitrogen, 138 pounds of phosphoric acid, and 307 pounds of potash. For the last six years of the life of the tree the average plant constituents removed per acre was 64 pounds of nitrogen, 18 pounds of phosphoric acid, and 40 pounds of potash.

It is calculated that a crop of wheat averaging 20 bushels per acre and $1\frac{1}{4}$ tons straw would remove 42 pounds nitrogen, 14 pounds phosphoric acid, and 20 pounds potash. In comparing these figures with those of the peaches we see that the draft on the soil for plant food for bearing peach trees is fully as great as that in the annual production of wheat. It is believed that many of the ills of the orchard that are laid to the work of insects and diseases are in a large measure due to the lack of cultivation and manuring.

The same station also reports results of a ten-year fertilizer experiment with peaches,[b] as a result of which it is concluded that it will pay to manure orchards on land that will yield 40 bushels of corn per acre. The average yield of fruit per acre in such orchards without fertilizers was 80 baskets per year and with fertilizers 185 baskets. Manures also prolonged the profitable bearing of the tree four or five

[a] New Jersey Stas. Bul. 197. [b] New Jersey Stas. Rpt. 1894, p. 125.

years. A complete fertilizer proved the most valuable and barnyard manure proved more effective from the standpoint of yield than did a complete commercial fertilizer. The manure, however, was applied at the rate of 10 loads per acre, which cost $30. The commercial fertilizers consisting of 150 pounds nitrate of soda, 350 pounds superphosphate, and 150 pounds muriate of potash, cost but $10.72 per acre, making the average cost of a basket of fruit but 4.4 cents, while where the barnyard manure was used the average cost was 11.6 cents per basket. From the standpoint of profit the commercial fertilizers were most effective.

At the New York State Station [a] an investigation was made to determine the amount of plant food used during one growing season by the fruit, leaves, and new growth of branches of the three varieties, Champion, Elberta, and Hills Chili. The trees were 7 to 9 years old and in full vigor of bearing. In this experiment the Champion tree produced 123.4 pounds of fruit pulp, 6.4 pounds stones, 46.3 pounds leaves, and 13.9 pounds of new wood. The Elberta tree produced 190.5 pounds of pulp, 15.4 pounds stones, 38.3 pounds leaves, and 5.5 pounds new wood. The Hills Chili produced 171.3 pounds pulp, 8 pounds stones, 52.7 pounds leaves, and 19 pounds wood. The following table shows the total weight of material produced and the amount of the more important food constituents removed from the soil:

Plant food removed by bearing peach trees.

Variety.	Total weight of fruit, wood, and leaves.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesia.
	Pounds.	*Pound.*	*Pound.*	*Pound.*	*Pound.*	*Pound.*
Champion	190.0	0.633	0.130	0.668	0.868	0.252
Elberta	249.6	.473	.151	.424	.929	.308
Hills Chili	251.0	.757	.175	.714	.056	.318

Based on the results secured in this work it is calculated that a bearing peach tree uses on the average the following approximate amounts of plant food constituents during the growing season: Nitrogen, 0.62 pound; phosphoric acid, 0.15 pound; potash, 0.6 pound; lime, 0.95 pound; magnesia, 0.3 pound. Estimating 120 trees to the acre, a peach orchard in full bearing would use 74.5 pounds of nitrogen, 18 pounds phosphoric acid, 72 pounds potash, 114 pounds lime, and 35 pounds magnesia yearly. In these investigations it was found that peach trees used larger amounts of plant food than any of the other deciduous fruits.

Earlier investigations at this station showed that nursery peach stock is not as exhausting on the soil as many farm crops.[b]

[a] New York State Sta. Bul. 265.

[b] New York State Sta. Rpt. 1902, p. 173.

The Connecticut State Station has been carrying on fertilizer experiments with peaches for more than ten years, and the data are annually given in the reports of the station,[a] but it is not yet thought safe to draw conclusions from this work. The Delaware Station also reports an experiment[b] in which the use of potash and phosphoric acid, either alone or combined, exercised no effect on the new growth of wood, while nitrogen, either alone or combined, increased the new growth in length fully 33 per cent. On another farm potash had no effect, while nitrogen increased the length of the new growth 6 per cent, and phosphoric acid alone 12 per cent.

At the West Virginia Station[c] the results of cooperative fertilizer tests indicate that on Romney shales a complete fertilizer compounded in the proportion of 60 to 80 ounces of dissolved boneblack, 20 to 30 ounces muriate of potash, 20 to 30 ounces nitrate of soda, and applied at the rate of 4 to 5 pounds to the tree for the first five years of growth in the orchard is likely to give very satisfactory results. The use of potash alone at the rate of 1 or 2 pounds per tree did little or no good, while the use of more than 2 pounds per tree killed trees in some instances. Light applications of potash combined with acid phosphate produced highly colored fruit. Thomas slag gave no better results than South Carolina rock.

At the New Jersey stations trees subject to an occasional overflow of salt water were not less subject to yellows than those not overflowed.[d] It was noted, however, that when the trees had been overflowed with salt water occasionally for a few hours at a time in the early spring they made a more vigorous healthy growth than those on the highland, but the fruit was less highly colored and there was no increase in the crop.

THINNING PEACHES.

According to a bulletin from the Maryland Station,[e] thinning increases the vitality of the tree by lessening the production of seed, tends to cause the tree to bear crops more regularly, lessens the loss occasioned by rot and other fungus diseases of fruit by eliminating the danger of infection by contact, causes larger and better colored fruit which can ripen up more uniformly, produces a more salable and higher priced fruit, preserves the shape of the tree, and prevents the breaking of overloaded branches.

The Delaware Station[f] reports the results of thinning peaches 4, 6, and 8 inches apart. The largest percentage of fancy fruits and firsts was secured by thinning from 6 to 8 inches apart. Trees thus

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[a] Connecticut Sta. Rpt. 1904, p. 444.
[b] Delaware Sta. Bul. 11; Rpt. 1893, p. 13.
[c] West Virginia Sta. Bul., 82.
[d] New Jersey Stas. Rpt. 1885, p. 152.
[e] Maryland Sta. Bul. 82.
[f] Delaware Sta. Rpt. 1902, p. 94.

thinned also produced as much fruit as those that were unthinned and more than those thinned to 4 inches apart.

The Michigan Station concludes, as the result of experimental work,[a] that the possibility of overthinning peaches is practically nil. A distance of 10 inches apart for fruit on peach trees appeared to be none too great in the station's experiments. Data were secured at the New Jersey stations[b] which indicated that nearly twice as many fruit buds matured on peach trees that had been severely thinned as on trees left unthinned. In one instance 70 per cent of the peaches was removed from the trees at thinning time, and on another lot of trees 32 per cent was removed. On the heavily-thinned tree 2.8 baskets of fruit were obtained, each fruit averaging 4.48 ounces in weight, and selling for $1 per basket. On the tree less severely thinned 3.9 baskets of fruit were obtained, each fruit averaging 2.8 ounces, for which 45 cents per basket was obtained. It is estimated that on an acre of 160 trees there was an advantage by thinning of $171.20.

As a result of work at the Canada Central Experimental Farm, it is concluded that when a big crop of peaches has set, thinning is highly remunerative.

S. A. Beach states as a result of a number of years' experiments in thinning peaches[c] that thinning considerably increases the size of the fruit and that early thinning is more effective for this purpose than late thinning. The effect of thinning the first year was not as marked in increasing the yield on the same tree the following year as was anticipated. Professor Beach believes that pruning is the most economical method of thinning the crop whenever this appears necessary, and that thinning fruits in commercial orchards with the expectation of inducing regular bearing and increased yields in succeeding years is of doubtful value. Systematic thinning of the fruit, however, combined with skillful care in other directions, may materially strengthen the tendency of the tree to bear annually. Peach trees may be severely impaired in vigor by maturing too heavy loads of fruit, but thinning should be the last resort after all the details of fertilizing, cultivating, spraying, pruning, etc., have been attended to.

A grower in California states,[d] as the result of a comparison between spring-pruned peaches after the fruit had set with winter pruning and thinning the fruit by hand, that the spring-pruned peaches were larger than the winter pruned and that spring pruning can replace winter pruning and thus save the cost of hand thinning.

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[a] Michigan Sta. Buls. 187, 205.

[b] New Jersey Stas. Rpts. 1900, p. 250; 1901, p. 253; American Agriculturist, 69 (1902), No. 21.

[c] California Fruit Grower, 29 (1902), Nos. 727, 728, 729.

[d] Pacific Rural Press, 61 (1901), No. 9.

PRUNING PEACHES.

At the Massachusetts Station[a] a row of peach trees was left nine years without pruning. As a result the trees grew open headed and generally assumed a vase form, the lower part of the main branches being bare and the fruiting wood sparse, weak, and high up in the trees. The trees were less thrifty and vigorous than pruned trees of the same variety. Other experiments at the same station indicate that heading back peach trees in early spring is good practice and in all cases advisable. From one-third to two-thirds of the length of the new branch growth of the previous year should be removed, depending upon the number of living fruit buds on the branch. When fruit buds are killed advantage should be taken to cut back with comparative severity. Only in extraordinary cases, however, should cutting extend back to 2 or 3 year old branches.

As the result of three years' experiments in pruning peach trees both in fall and in spring at the Michigan Station[b] it would seem that the best time to prune is early in the spring before or at the time the sap begins to circulate. It was noticed that when the trees were fall pruned some of the branches killed back instead of healing over, as they do when spring pruned. The yield of fruits proved to be practically the same on the fall-pruned and spring-pruned trees. "The practice of heading-in the peach trees in the fall or early winter, or at any time in the winter when the wood is frozen, if continued would seriously injure the trees."

In a bulletin devoted to pruning and training peach orchards by the Texas Station[c] a low-headed form of tree is advocated as a protection against sun scald and greater advantage in harvesting the fruit. At the California Station the fruit was larger when the trees were pruned after the fruit had set and the additional expense of thinning was avoided.[d] The Delaware,[e] Missouri,[f] and Tennessee[g] stations have published popular bulletins devoted to the subject of pruning.

RENEWING BY PRUNING.

Peach orchards are often rejuvenated by pruning back when the trees begin to show signs of lack of vigor. The old limbs are severely pruned back, as the result of which many new branches push out and these are thinned out sufficiently to make a good top. The New Jersey stations[h] consider this method of removing the orchard entirely practicable as a means of prolonging the life of the orchard. If, however, the trees are dying because of the ravages of disease or

[a] Massachusetts Sta. Rpt. 1904, p. 162.
[b] Michigan Sta. Buls. 194, 205; Special Bul. 30.
[c] Texas Sta. Bul. 58.
[d] California Sta. Rpt. 1898, p. 314.
[e] Delaware Sta. Bul. 62.
[f] Missouri Sta. Bul. 55.
[g] Tennessee Sta. Bul. Vol. 17, No. 3.
[h] New Jersey Stas. Rpt. 1900, p. 255.

insects, or of proper fertilization and cultivation, it will not be practicable. If there is a marked lack of vigor in the tree cutting off one or two of the main branches a year will be a safer method, thus rejuvenating the tree gradually.

At the New Mexico Station[a] three methods of cutting back old peach trees were tried. In the first place branches 5 or 6 years old were cut back to stubs 4 or 5 feet high, in the second only wood 3 to 4 years old was taken off, and in the third only 2-year old wood removed. A good growth was secured in all cases, but on the trees which were pruned back most severely the bearing wood was brought nearer to the ground, which, of course, was an advantage in harvesting. It is urged that this vigorous pruning be not put off until the tree is in a rapid decline.

HARVESTING AND SHIPPING PEACHES.

RIPENING.

The chemical changes which occur in the ripening of peaches were studied by W. D. Bigelow and H. C. Gore, of this Department.[b] The work of analysis began immediately after the June drop. The fruit was examined again when the stone began to ripen, when the fruit was market ripe, and when fully ripe. The data secured showed that the peach contained no starch at any stage of its growth. Between the time of the June drop and market ripeness the peach increased in size about eight times. The weight of the sugar in the pulp increased nearly eight times, and the sucrose and acids increased considerably more than this. The various forms of nitrogenous substances all increased in weight from the beginning to the end of the period of observation. Between market ripeness and full ripeness considerable growth took placc, there being an increase in both water and solid content and in reducing sugars and sucrose.

SHIPPING PEACHES.

As a result of experiments in shipping fruits to Winnipeg, J. B. Reynolds states[c] that the best possible results were secured when the fruit for shipping had been left on the tree until it had attained its full size. It was picked while still firm, but before the yellow tints, significant of ripeness, began to appear.

H. M. Stringfellow calls attention[d] to the specially good keeping quality of peaches grown in sod orchards. He sent peaches from Texas to Richmond, Va., Rochester, N. Y., and Harrisburg, Pa.,

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[a] New Mexico Sta. Bul. 39.

[b] U. S. Dept. Agr., Bureau of Chemistry Bul. 97.

[c] Ontario Agr. Rev., 17 (1904), No. 3.

[d] Texas Farm and Ranch, 24 (1905), No. 38.

where they arrived in perfect condition, without refrigeration. One shipment to Rochester, N. Y., was returned to Texas without ice, reaching there in good condition. Powell and Fulton, of this Department, as a result of their investigations,[a] state that in shipping peaches picking must be done carefully to prevent all bruising. The fruit should be fully grown and well colored, but firm when picked. It should be transferred from the orchard to the cars or the storage room as soon as possible after removal from the trees. If picked in the morning it may be 20° F. cooler than if picked later in the day, and unless artificially cooled should be placed on the cars before losing this cool temperature.

It was found that if peaches are cooled quickly to about 40° F. before being loaded into refrigerator cars they will carry to the most distant northern markets without loss, while if the peaches are picked and sent from the orchard to cars cooled in the ordinary way with ice, as much as 30 per cent of the layers in the upper part of the car may be spoiled. Much of the losses in transportation of peaches can be overcome if the temperature of the fruit is reduced quickly after picking.

In shipping peaches to Paris, Mr. Wright, of Delaware,[b] was most successful when the peaches were picked green, then wrapped in tissue, then cotton, and finally in blotting paper, and shipped in 6-basket carriers. Peaches shipped by West Virginia growers[c] to England gave much larger net returns than when shipped to New York.

COLD STORAGE OF PEACHES.

The freezing of the juices of different varieties of peaches was found by the Ontario Agricultural College[d] to vary between 29.3° and 30° F., from which it is calculated that the freezing point of the fruits themselves would be if anything lower than this.

Peaches are not usually stored for any length of time. Storing may be of use as a temporary measure to prevent or avoid a glut in the market, or to fill in the gaps between the crops of different regions. The investigations of Powell and Fulton[e] show clearly that it is not profitable to put peaches into cold storage for any length of time under any circumstances, unless the condition of the fruit and the storage conditions are most favorable. "In normal ripening the peach passes from maturity to decay in a few hours in hot, humid weather. The aroma and flavor are most delicate in character and are easily injured or lost."

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[a] U. S. Dept. Agr., Bureau of Plant Industry Bul. 40.

[b] Agr. Gaz. N. S. Wales, 12 (1904), No. 1.

[c] West Virginia Sta. Bul. 82.

[d] Ontario Agr. College and Experimental Farm Rpt. 1903, p. 13.

[e] U. S. Dept. Agr., Bureau of Plant Industry Bul. 40.

In storage experiments fruit that was highly colored and firm when picked and placed in the storage house kept in prime commercial condition from two to three weeks at a temperature of 32° F. For this length of time the quality of the fruit was retained, and it stood up well for two or three days after removal from storage, depending upon weather conditions. After three weeks in storage, however, the quality of the fruit deteriorated, though the peaches in appearance were firm and bright. When the fruit was mellow when placed in storage it deteriorated more quickly both during storage and after withdrawal. If unripe, it shriveled considerably. Much less favorable results were secured in storing at a temperature of 36° and 40°, respectively.

The best packages for long storage periods seemed to be 20-pound boxes in which the circulation of air was restricted. Wrapping the fruit proved a great protection against bruising in transit.

Bigelow and Gore made a special study of the effect of storage on the composition of market ripe peaches.[a] One lot was kept in ordinary room temperature (77° to 86°), another in a temperature of 32° F., and a third lot in a common refrigerator (54° to 59° F.). By storing at ordinary room temperature marked changes occurred within two or three days. Those stored at 32° F. changed much more slowly. At the end of three or four weeks, however, the flesh began to discolor and lose flavor. The changes in the composition of the peaches stored in the common refrigerator were intermediate between those stored at summer temperature and those in cold storage. In other experiments the rate of ripening of green peaches was not markedly more rapid than that of more matured fruit.

From experiments reported by A. H. Benson,[b] he concluded that only solid flesh clingstones can be kept in a salable condition for more than a month. French experiments also indicate that from thirty-five to forty days represents the life of the peach in cold storage.[c]

COMPOSITION OF PEACHES.

The composition of the twigs, buds, and blossoms of peaches and of the entire green fruit at two different stages of growth and at maturity was determined by the Delaware Station.[d] At the time of taking the first sample of green fruits, 100 fruits on the average weighed 2.2 pounds. At the next sampling 6 pounds and at maturity 28.6 pounds. The following table shows the sugar, starch, and fertilizing constituents of the different parts on the different dates of examination:

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[a] U. S. Dept. Agr., Bureau of Chemistry Bul. 97.

[b] Agr. Gaz. N. S. Wales, 4 (1893), No. 11.

[c] De la conservation des fruits par les procédés basés sur l'emploi du froid. Paris: Librairie et Imprimerie Horticoles, 1903.

[d] Delaware Sta. Rpt. 1902, p. 87.

Analyses of twigs, buds, blossoms, and fruit of peaches.

Part and date of cutting, 1902.	Natural state.					
	Moisture.	Potash.	Phosphoric acid.	Nitrogen.	Sugar.	Starch.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Twigs, March 25	52.87	0.29	0.11	0.50	2.88	16.55
Buds, March 26	55.61	.74	.38	1.23	.93	5.10
Blossoms, April 24-25	81.41	.57	.16	.69	2.86	2.06
Entire peach, June 6	87.97	.29	.02	.16	2.95	2.31
Entire peach, June 28	82.76	.33	.05	.18	1.98	3.64
Entire peach, August 25	83.24	.29	.03	.10	7.42	1.98

Unlike the results reported by Bigelow and Gore, starch was found at all stages of growth not only in the green but also in the ripe fruit. The composition of the flesh, pits, and kernels of mature peaches in the absolute dry state was also determined by the station and is shown in the following table:

Analyses of different parts of the peach.

Part.	Absolutely dry state.				
	Potash.	Phosphoric acid.	Nitrogen.	Sugar.	Starch.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Flesh of peach, August 25	2.32	0.24	0.63	61.94	7.31
Shells of pits, August 25	.33	.08	.19	3.21	25.10
Kernels of pits, August 25	1.02	.64	4.08	....	....

At the Connecticut Station [a] green peaches removed at the time of thinning were found to contain the following amounts of different elements in a ton of peaches: Potash 7.3 pounds, sodium 0.16 pound, lime 0.56 pound, magnesia 0.59 pound, oxid of iron and alumina 0.16 pound, phosphoric acid 1.8 pounds, sulphuric acid 0.38 pound, chlorid 0.3 pound, sand and silicate 0.47 pound, and nitrogen 6.4 pounds. "It appears that a ton of this fruit contained about as much nitrogen and potash as 200 pounds of nitrogenous superphosphate of average quality but much less phosphoric acid."

The California Station [b] reports physical analyses of the varieties Orange Cling and Lemon Cling. The flesh constituted a little more than 93 per cent of each of these varieties and the pits a little more than 6 per cent. Orange Cling contained 78.5 per cent water, 20.88 per cent of organic matter, and 0.62 per cent of ash, while Lemon Cling contained 86.5 per cent water, 13.06 per cent organic matter, and 0.44 per cent ash. On the average the whole ripe fruit contained 12.5 per cent of sugar, flesh 13.4 per cent, juice 17 per cent, and 0.24 per cent of acid.

[a] Connecticut Sta. Rpt. 1893, p. 60.
[b] California Sta. Bul. 97.

According to investigations of the Montana Station[a] salicylic acid is normally present in fresh peaches as well as in many other fruits in very small quantities. The exact amount in the case of peaches was not determined.

JUDGING PEACHES.

The following scale of points for judging peaches is suggested by F. A. Waugh:[b] Form 15, size 10, color 20, uniformity 20, quality 15, freedom from blemishes 20. Total 100.

CANNING.

Some data have been accumulated at the stations on the canning of peaches. At the southern California Culture Substation [c] a test was made of canning peaches. Six boxes of Yellow Tuscany Cling, California Cling, McDevitt Cling, Runyon Orange Cling, Sellers Cling, and Nichol Orange Cling were assorted and sent to a cannery and put through the process with the regular pack of other fruits supplied by local growers. At the end of the season the cans were opened and the fruit examined with reference to the appearance of the fruit as to color, absence of red at the pit, firmness of flesh, and clearness of juice. The results, as determined by the best local experts, were as follows:

> Sellers Cling and Yellow Tuscany stood first in firmness, absence of red at the pit, and color. Yellow Tuscany stood first in clearness of juice; McDevitt Cling stood second in this respect, and the other clings were considered decidedly inferior to the above as canning peaches, not only in quality, but in firmness and appearance. California Cling had the greatest number of split pits; Nichol Cling and McDevett came next in this regard. Sellers Cling was entirely, and Yellow Tuscany was, practically, free from split pits.

Yellow Tuscany is considered a very productive variety. Lovell is regarded as the most promising of the yellow freestones for canning or drying.

At the Canada Experimental Farms [d] the varieties of peaches in order of preference for canning purposes were, late Crawford, followed by Smock, Longherst, Wager, and Early Crawford.

At the Louisiana stations [e] when high-grade peaches or pears were put in 3-pound cans and about 1½ pounds of sugar used for the sirup in each dozen cans the cost of labor and material with a cheap canning outfit for a day's labor was as follows: Labor $5.40, 400 3-pound cans at 3 cents each $12, 50 pounds sugar $3, total, $20.40. The output was 400 3-pound cans. This grade of goods sold for $1.75 per dozen cans. When peaches were put up without sugar, using simply

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[a] Montana Sta. Bul. 38.

[b] Western Fruit Grower, 14 (1903), No. 5, p. 1.

[c] California Sta. Rpt. 1898.

[d] Canada Experimental Farms Rpt. 1896, p. 164.

[e] Louisiana Stas. Bul. 81.

clear water, the same grade sold as pie peaches and brought $1 per dozen cans. One bushel of peaches on the average filled only 16 3-pound cans, while a bushel of pears filled on the average 24 3-pound cans. It cost as much to put up one as the other and they sold at about the same price, grade for grade.

PROFITS.

The costs and profits from peach culture were studied at the Mississippi Station [a] in a 6-acre orchard made up of 94 per cent of Elbertas. The cost of the trees and the expense of preparing the land and planting was $66.75, and the care of the orchard up to the time the trees came in bearing $270, making a total expense of $336.75, up to the bearing period. The culture of sweet potatoes and peas between the rows during this period brought in a total of $390, thus paying the entire cost of the orchard and leaving a profit of $53.25, which may be regarded as good rental value of the land for three years, at the end of which time the orchard was ready for fruit bearing. For the next four years the average returns from the orchard were $104.16 per acre and the annual expense of caring for the orchard $30 per acre, leaving a clear gain of $74.16 for each acre during four years.

A New Jersey peach grower, S. B. Voorhees, states,[b] as a result of fifteen years' experience, that in an orchard of 25 acres containing 3,000 bearing trees the number of baskets marketed has averaged 5,160 annually, the gross receipts for the same $2,800, the average cost of baskets, picking, carting, and marketing 25 cents, and the average net receipts 29½ cents per basket.

LITERATURE.

A large number of the experiment stations have published practical treatises on peach culture with reference to local conditions. These treat as a general thing very fully of the details of peach culture, including control of insect and fungus diseases and descriptions of the varieties best suited for different purposes. Among the more important of these are: Canada Central Experimental Farm, Bulletin 1, new series; Georgia Station Bulletin 42; Maryland Station Bulletin 72; Michigan Station Bulletin 103; Missouri Station Bulletin 38; Missouri State Fruit Station Bulletin 12; New Jersey Stations Bulletins 133 and 197; New Mexico Station Bulletin 30; New York Cornell Station Bulletin 74; North Carolina Station Bulletin 120; Ohio Station Bulletin 170; Pennsylvania Station Bulletin 37; Texas Station Bulletins 39 and 80; West Virginia Station Bulletin 82; U. S. Department of Agriculture Farmers' Bulletin 33; separate from the Yearbook for 1902, entitled Cultivation and Fertilization of Peach

[a] Mississippi Sta. Bul. 93. [b] Proc. New Jersey Hort. Soc. 25, 1900.

Trees; Division of Pomology Circular 3, entitled Notes on Fruit Culture.

A practical handbook on the cultivation in Great Britain of peaches under glass and out of doors against walls has also recently appeared. The work is entitled "The Book of the Peach," by H. W. Ward, London; Walter Scott Pub. Co., Ltd., 1903, pp. 113, pls. 1, figs. 28.

CONCLUSIONS.

Among the more important facts which seem to have been brought out in the experiments herein reported may be mentioned the following:

The peach normally makes about four-fifths of its wood growth by midsummer. Cultivation for the sake of the tree should, therefore, be done early in the season. By the end of July the flower buds begin to form in the South, and in the North by September.

Dormant, well-ripened flower buds will stand a temperature many degrees below zero, when less mature buds may be killed by even zero weather. There is a marked difference in the hardiness of different varieties, those of the Peen-to race being the tenderest and those of the Persian race the hardiest.

The pistil of a flower bud is the first to show injury from freezing, taking on a brownish or blackened appearance. The buds swell and blossom when conditions above the ground are favorable. Blooming is in a large measure independent of root action. Early varieties generally bloom later than late varieties. Peaches appear to be quite generally self-fertile.

In localities where flower buds are normally killed by cold a crop can generally be secured by laying down the trees on the approach of winter and protecting with a light covering until danger from frost is past in spring.

Whitewashing is a cheap method of retarding the swelling of fruit buds in the winter and delaying blooming in the spring.

Winter injury is most severe in orchards or individual trees of low vitality induced either by lack of cultivation or fertilizers, the attacks of insects or diseases, overbearing, poor physical condition of the soil, drought, excessive moisture, etc.

A mulch of weeds, grass, cover crops, manure, etc., greatly lessens the winter injury over that in orchards on bare ground. To avoid winter injury to the greatest extent such thorough cultural practices must be maintained as will keep the trees in a vigorous, thrifty condition all the time. The fertility and vegetable matter of the soil must be maintained by the addition of manure or the growing of cover crops, and spraying to control insect pests and fungus diseases must be thorough and unremittent.

It is difficult to tell by the examination of fruit trees the extent of any winter injury. Trees which, examined in the winter, seem to be dead beyond doubt frequently recover. The best treatment for old trees appears to be medium pruning—cutting back the limbs into 2 or 3 year-old wood. Much more severe pruning may be practiced with young trees than with old ones. Good cultivation and light fertilizing should follow to help the trees overcome the injury.

The peach normally should be pruned back each spring from one-half to two-thirds of the previous season's growth, otherwise trees with bearing wood far out on the ends of the branches and naked trunks below will be produced. When the fruit buds are winter-killed, advantage should be taken to prune more severely in order to keep the tree in a compact form, with the fruiting wood near the ground. Old trees may be rejuvenated by severely pruning back part of the limbs each year.

Seedling peach trees are best for nursery stock. Sand cherry (*Prunus besseyi*) is a good dwarfing stock. On alkali soils plum stocks appear to give better results than peach stock.

In transplanting nursery stock to the orchard the roots may be profitably pruned back from 5 to 8 inches in length and the trunks left from 16 to 24 inches long.

The peach orchard should be so treated that the wood and buds will be thoroughly dormant when winter sets in. Cover crops other than the legumes planted in midsummer seemed to favor early ripening of the wood. In dry regions the cover crop should be one that will stand up during the winter, catch and hold the snow, and also be killed by the first fall frosts so that all the moisture of the soil may be left for the use of the tree during the winter.

Trees on high land appear to ripen up earlier than those on low ground.

Winter irrigation seems to be a desirable practice in some of the more arid Western States.

Peaches require as heavy fertilizing as wheat. They may be profitably fertilized when planted on land that would normally yield 40 bushels of corn per acre. The profitable bearing age of the orchard may be prolonged several years by the use of fertilizers. Peaches draw specially heavy on the nitrogen and potash of the soil.

Thinning peaches is a desirable commercial practice in seasons of great abundance. It should follow thorough cultivation, manuring, and spraying. The benefits arise primarily from the larger amount of fancy and first-class fruit. Thinned trees appear also to develop more fruit buds than unthinned. Much of the thinning can be done by spring pruning, either before or after the fruit is set.

Six to 10 inches apart is close enough for the fruits to remain on the branches.

Peaches for market should be left on the tree until they have attained full size and are well colored but still firm. They ship best if cooled before putting on the cars. Thus harvested, carefully handled, and placed in cold storage at 32° F. in small packages they may be safely kept for three weeks, after which the quality rapidly deteriorates.

A bushel of peaches will fill on the average 16 3-pound cans.

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